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## FIELD EFFICACY AND ECONOMICS OF BIOPESTICIDES AGAINST *Aproaerema modicella* (DEVENTER) AND *Spodoptera litura* (FABRICIUS) IN KHARIF GROUNDNUT

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### ABSTRACT

Field experiments were conducted during *Kharif*, 2012, *Kharif*, 2013 and *Kharif*, 2014 at with the objective of evaluating the efficacy and economics of different biopesticides against leaf miner and tobacco caterpillar in groundnut. The treatments *viz.*, release of *Trichogramma chilonis* parasitoid, *Bt.k.*, *Beauveria bassiana*, SINPV, NSKE and standard chemical check, quinalphos were applied in alone and in different combinations in eight different schedules including untreated check. Results revealed that two sprays of quinalphos (79.6%) followed by NSKE 5% (71.9%), *B. bassiana* @ 2.5 kg ha<sup>-1</sup> (57.2%) and *Bt.k* @ 1.5 kg ha<sup>-1</sup> (55.9%) at 30 DAS & 55 DAS found effective in reducing leaf miner larval population, whereas, two sprays of NSKE 5% (64.0%) and quinalphos (62.9%) followed by a spray of *B. bassiana* at 30 DAS and subsequent spray of SINPV at 55 DAS (52.3%) found effective against tobacco caterpillar. Significantly highest pod yield of 2570 kg ha<sup>-1</sup> was recorded in quinalphos treatment and it was at par with NSKE5%(2510 kg ha<sup>-1</sup>) followed by first spray of *B. bassiana* and subsequent spraying of SINPV(2228 kg ha<sup>-1</sup>). The highest incremental cost-benefit ratio of 19.2 and 18.7 was recorded in treatment schedule comprising two sprays of quinalphos and NSKE 5%, respectively. Among the biopesticides, two scheduled sprays of *Bt.k* recorded higher incremental CB ratio as compared to other biopesticide treatments.

### INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a leading oilseed crop in India and an important oilseed crop of tropical and subtropical regions of the world. Groundnut is considered by farmers as remunerative crop with relatively low chance of crop failures despite an unpredictable monsoon. However, the insect pests form an important constraint in groundnut production. In the rainy season, leaf miner, *Aproaerema modicella* (Deventer); tobacco caterpillar, *Spodoptera litura* (Fabricius); red headed hairy caterpillar, *Amsacta albistriga* and off late, gram caterpillar, *Helicoverpa armigera* (Hubner) are economically important pests in groundnut as defoliators during the pegging, podding and pod maturation stages of growth (Hanamant and Mahabaleswar, 2014). Yield losses due to the leaf eating caterpillars particularly *A. modicella* alone can reach up to 89 % (Nandagopal and Ghewande, 2004). Mostly chemical pesticides are being used to control these caterpillar pests on groundnut and very rarely do farmers use

alternative cultural, physical or biological methods. A number of parasites, predators and pathogens are reported but they have not been used for biological control under field conditions (Ghewande *et al.*, 1997). Additionally, many pests including *S. litura* have developed resistance to many commercially available pesticides (Kranthi *et al.*, 2002). Adverse effects due to synthetic pesticides on pests and their subsequent impact on ecological imbalance (Zadoks and Waibel, 1999) demands eco-friendly alternatives (Parmar, 1993).

Changing scenario in pest management concept has brought the natural products to the forefront as an effective and reliable pesticidal molecule in the control of pests among crops. Biopesticides are one such alternative and an important component in Integrated Pest Management (IPM) since they are economically and environmentally safe and can be easily integrated with other control measures (Isman, 2006). Recent advances in production, stabilization, formulation and

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application have led the way towards commercialization of a large number of new biopesticide products (Faria and Wraight, 2007). Hence, it is worthwhile to test their bio-efficacy and possible utilization of these biopesticides in groundnut IPM is imperative. Hence, the study was undertaken to identify biological alternatives to pesticides in the management of leaf eating caterpillars of groundnut.

## MATERIAL AND METHODS

Field trials were carried out at Agricultural Research Station, Darsi, Prakasam Dist. of Andhra Pradesh during *Kharif*, 2012, *Kharif*, 2013 and *Kharif*, 2014 to assess the efficacy of selected biopesticides against *A. modicella* and *S. litura* in groundnut. The experiments were conducted in Randomized Block Design (RBD) with eight treatments including untreated control and standard with three replications for each treatment. K-6 variety of groundnut was sown at a spacing of 30 cm × 10 cm and cultivated under recommended irrigation method. The plot size for each treatment was 9.6 sq.m. and each plot was separated from the adjacent plot by providing one feet soil. Each treatment was imposed in three randomized plots. Recommended package of practices were followed to raise good crop.

When the pest population crossed the economic threshold level (ETL), two rounds of sprays were given at 30 days after sowing (DAS) and 55 DAS. The treatments were applied with knapsack sprayer using a spray fluid of 500 l ha<sup>-1</sup>. Spraying was carried out in the evening hours mainly during low wind velocity. Pre-treatment count of pest population was taken before spraying. Post-treatment counts were taken at three, five, and 10 days after spraying. Larval population of *A. modicella* and *S. litura* was recorded from ten plants selected at random from each plot and expressed as average number per plant and the mean data from such of three seasons was used in the table of expression. The data was subjected to Duncan Multiple Range

Test (DMRT) to assess the significance of treatments with untreated control and standard (pesticide treatment) using the statistical software SPSS 11.5 version.

Yield and yield economics were worked out after the crop attained maturity. The economics of different treatments were worked out based on the pod yield and cost of protection and sale price of the pods. Based on the cost of treatment and the gross profit in different treatments, net profit was calculated. Incremental benefit was calculated by taking the difference in gross profit from the respective treatments over the control. Further, the Incremental Benefit Cost (IBC) ratio was obtained by taking the ratio of incremental benefit to the cost of treatment.

## RESULTS AND DISCUSSION

### Evaluation of biopesticides against leaf miner

The leaf miner larval population recorded one day before imposing treatments (first spray) revealed that all the treatments including untreated check have uniform larval load with a mean population of 2.41 larvae plant<sup>-1</sup> to 3.08 larvae plant<sup>-1</sup> which was statistically non-significant. Three days after the first spraying, significant difference in larval population of *A. modicella* was observed between the treatments and lowest larval incidence was observed in standard chemical check, quinalphos (0.67 larvae plant<sup>-1</sup>) which differed significantly from remaining treatments followed by NSKE 5% with a population of 0.87 larvae plant<sup>-1</sup>. *B. bassiana* @ 2.5 kg ha<sup>-1</sup> recorded 1.13 larvae plant<sup>-1</sup> and was statistically at par with other dose of *B. bassiana* @ 2.0 kg ha<sup>-1</sup> and *Bt.k* @ 1.5 kg ha<sup>-1</sup> with identical population of 1.27 larvae plant<sup>-1</sup>. After five days of spraying, standard check quinalphos maintained its superiority by recording significantly lowest larval population (0.37 larvae plant<sup>-1</sup>) and was statistically different from remaining treatments. It was followed by *B. bassiana* @ 2.5 kg ha<sup>-1</sup> (0.77 larvae plant<sup>-1</sup>) which was at par with NSKE 5% (1.03 larvae plant<sup>-1</sup>), *B. bassiana* @ 2.0 kg ha<sup>-1</sup> and *Bt.k* @ 1.5 kg ha<sup>-1</sup> (1.17 larvae plant<sup>-1</sup>).

*Bt.k* @ 1 kg ha<sup>-1</sup> (1.27 larvae plant<sup>-1</sup>) and release of *T. chilonis* plots (1.63 larvae plant<sup>-1</sup>) were at par but significantly different from untreated control which recorded 3.03 larvae plant<sup>-1</sup> (Table 1). Observations recorded at 10 days after first spraying revealed that lowest population was recorded in NSKE 5% (0.60 larvae plant<sup>-1</sup>) which was statistically different from remaining treatments and it was followed by quinalphos (0.77 larvae plant<sup>-1</sup>). *Bt.k* @ 1.5 kg ha<sup>-1</sup> (1.10 larvae plant<sup>-1</sup>), *B. bassiana* @ 2.5 kg ha<sup>-1</sup> (1.17 larvae plant<sup>-1</sup>), *Bt.k* @ 1.0 kg ha<sup>-1</sup> (1.33 larvae plant<sup>-1</sup>) and *B. bassiana* @ 2.0 kg ha<sup>-1</sup> (1.50 larvae plant<sup>-1</sup>) were statistically at par with each other. Release of *T. chilonis* plots recorded larval population of 1.53 larva plant<sup>-1</sup> and it differed from untreated check (3.10 larvae plant<sup>-1</sup>).

The mean larval population one day before second spray ranged from 2.38 larvae plant<sup>-1</sup> to 3.06 larvae plant<sup>-1</sup> across the treatment plots. Three days after second spraying, lowest larval population (0.47 larvae plant<sup>-1</sup>) of *A. modicella* was recorded in quinalphos and was significantly superior to all the other treatments. NSKE 5% was next best treatment to record 0.73 larvae plant<sup>-1</sup> which was on par with *Bt.k* @ 1.5 kg ha<sup>-1</sup> (1.20 larvae plant<sup>-1</sup>), *B. bassiana* @ 2.5 kg ha<sup>-1</sup> (1.27 larvae plant<sup>-1</sup>) and differed significantly with remaining treatments and also untreated check which recorded maximum larval population of 2.93 plant<sup>-1</sup>. The quinalphos treatment remained effective even after five and 10 days of treatment imposition and differed significantly with all the other treatments followed by NSKE 5%. All the remaining treatments supported at par except release of *T. chilonis* plots which recorded comparatively higher population of leaf miner after 5 days and 10 days of second spraying. The untreated check recorded highest population of 2.87 larvae plant<sup>-1</sup> and 3.10 larvae plant<sup>-1</sup> after 5 days and 10 days of second spraying, respectively and remained statistically different from all the other treatments (Table 1).

Similar trend was observed in overall mean population of *A. modicella* after two sprayings. The lowest larval population was recorded in plots that received two sprays of quinalphos (0.61 larvae plant<sup>-1</sup>) followed by two sprays of NSKE 5% (0.84 larvae plant<sup>-1</sup>). Two sprays of *B. bassiana* @ 2.5 kg ha<sup>-1</sup> (1.28 larvae plant<sup>-1</sup>) and *Bt.k* @ 1.5 kg ha<sup>-1</sup> (1.32 larvae plant<sup>-1</sup>) at 30 and 55 DAS were at par. Spray schedule comprising *Bt.k* @ 1.0 kg ha<sup>-1</sup> at 30 DAS followed by second spraying of SINPV at 55 DAS (1.61 larvae plant<sup>-1</sup>) and one spray of *B. bassiana* @ 2.0 kg ha<sup>-1</sup> at 30 DAS followed by second spraying of SINPV at 55 DAS (1.62 larvae plant<sup>-1</sup>) recorded at par population, however, significantly different from earlier two treatments. *A. modicella* larval population was highest in tricho cards pinned plots (1.83 larvae plant<sup>-1</sup>) which differed significantly from untreated control (2.99 larvae plant<sup>-1</sup>). Percentage (%) reduction in larval population of leaf miner over control was highest in plots received two sprays of quinalphos (79.6%) followed by NSKE 5% (71.9%) while two sprays of *B. bassiana* @ 2.5 kg ha<sup>-1</sup> (57.2%) and *Bt.k* @ 1.5 kg ha<sup>-1</sup> (55.9%) at 30 DAS & 55 DAS were next effective treatments which were at par. Lowest % reduction in larval population of leaf miner over control was recorded in tricho cards pinned plots (37.8%) after two rounds of treatments imposition and failed to establish its effectiveness against leaf miner in groundnut. The efficacy of neem formulations against leaf miner in groundnut was earlier reported by Prabhakar *et al.* (1994) and Kumar and Krishnayya (1999). Patil *et al.* (2003) also reported that NSKE @ 5% was most effective against groundnut leaf miner. The result of the study was in line with Sahayaraj and Namachivayam (2011) and Hanamant and Mahabaleswar (2014) who reported the effectiveness of *B. bassiana* on groundnut leaf miner in reducing the larval population. Application of talc-based formulation of *B. bassiana* through seed, soil and foliar spray effectively reduced the incidence of leaf miner in groundnut compared to individual bio-formulation and control treatments both

**Table 1. Effect of different biological control practices in suppression of leaf miner, *Aproaerema modicella* (Deventer) in Groundnut (Pooled data of Kharif, 2012, Kharif, 2013 and Kharif, 2014)**

Treatments	* Mean no. of leaf miner larvae / plant										% reduction over control†
	One day before first spray	Days after first spray (30 DAS)			One day before second spray	Days after second spray (55 DAS)			Mean of two sprays		
		3 <sup>rd</sup> day	5 <sup>th</sup> day	10 <sup>th</sup> day		3 <sup>rd</sup> day	5 <sup>th</sup> day	10 <sup>th</sup> day			
										3 <sup>rd</sup> day	
Release of <i>Trichogramma chilonis</i> @ 1,00,000 ha <sup>-1</sup> at 30 & 55 DAS	2.41 (1.70)	1.73 (1.49) <sup>b</sup>	1.63 (1.46) <sup>b</sup>	1.53 (1.42) <sup>b</sup>	2.79 (1.82)	1.87 (1.53) <sup>b</sup>	2.13 (1.63) <sup>b</sup>	2.30 (1.67) <sup>b</sup>	1.87 (1.53) <sup>b</sup>	37.57 (37.79) <sup>e</sup>	
<i>Bt.k</i> (Halt 5%WP) @ 1.5 kg ha <sup>-1</sup> at 30 DAS & 55 DAS	2.63 (1.76)	1.27 (1.33) <sup>c</sup>	1.17 (1.28) <sup>c</sup>	1.10 (1.27) <sup>bcd</sup>	2.59 (1.75)	1.20 (1.30) <sup>c</sup>	1.07 (1.25) <sup>d</sup>	2.13 (1.63) <sup>b</sup>	1.32 (1.35) <sup>d</sup>	55.94 (48.42) <sup>c</sup>	
<i>Bt.k</i> (Halt 5%WP) @ 1 kg ha <sup>-1</sup> at 30 DAS and SINPV @ 250 LE ha <sup>-1</sup> at 55 DAS	2.99 (1.86)	1.47 (1.41) <sup>bc</sup>	1.27 (1.33) <sup>bc</sup>	1.33 (1.35) <sup>bc</sup>	2.68 (1.78)	1.87 (1.53) <sup>b</sup>	1.67 (1.47) <sup>bc</sup>	2.07 (1.61) <sup>b</sup>	1.61 (1.45) <sup>c</sup>	46.12 (42.77) <sup>d</sup>	
NSKE @ 5% at 30 DAS & 55 DAS	2.97 (1.86)	0.87 (1.16) <sup>de</sup>	1.03 (1.23) <sup>cd</sup>	0.60 (1.05) <sup>d</sup>	2.38 (1.70)	0.73 (1.11) <sup>cd</sup>	1.07 (1.25) <sup>d</sup>	0.73 (1.10) <sup>d</sup>	0.84 (1.15) <sup>e</sup>	71.85 (57.99) <sup>b</sup>	
<i>Beauveria bassiana</i> @ 2.5 kg ha <sup>-1</sup> at 30 DAS & 55 DAS	2.76 (1.80)	1.13 (1.27) <sup>cd</sup>	0.77 (1.13) <sup>d</sup>	1.17 (1.27) <sup>bcd</sup>	2.68 (1.79)	1.27 (1.33) <sup>bc</sup>	1.20 (1.29) <sup>cd</sup>	2.13 (1.63) <sup>b</sup>	1.28 (1.33) <sup>d</sup>	7.17 (49.13) <sup>c</sup>	
<i>Beauveria bassiana</i> @ 2 kg ha <sup>-1</sup> at 30 DAS and SINPV @ 250 LE ha <sup>-1</sup> at 55 DAS	2.82 (1.82)	1.27 (1.33) <sup>c</sup>	1.17 (1.29) <sup>c</sup>	1.50 (1.41) <sup>bc</sup>	2.63 (1.76)	1.93 (1.55) <sup>b</sup>	1.73 (1.50) <sup>b</sup>	2.13 (1.62) <sup>b</sup>	1.62 (1.46) <sup>c</sup>	45.93 (42.65) <sup>d</sup>	
Quinalphos 25 EC @ 1 l ha <sup>-1</sup> at 30 DAS & 55 DAS	3.08 (1.89)	0.67 (1.07) <sup>e</sup>	0.37 (0.92) <sup>e</sup>	0.77 (1.13) <sup>cd</sup>	3.06 (1.89)	0.47 (0.97) <sup>d</sup>	0.37 (0.93) <sup>e</sup>	1.03 (1.23) <sup>c</sup>	0.61 (1.06) <sup>f</sup>	9.58 (63.16) <sup>a</sup>	
Untreated Check	2.99 (1.87)	2.93 (1.85) <sup>a</sup>	3.03 (1.87) <sup>a</sup>	3.10 (1.89) <sup>a</sup>	2.76 (1.80)	2.93 (1.84) <sup>a</sup>	2.87 (1.84) <sup>a</sup>	3.10 (1.90) <sup>a</sup>	2.99 (1.87) <sup>a</sup>	0.00 (1.62) <sup>f</sup>	
<b>CD (P ≤ 0.05)</b>	NS	0.15	0.16	0.30	NS	0.23	0.19	0.10	0.07	3.79	
<b>CV%</b>	4.78	6.54	6.95	12.38	3.77	9.49	7.74	3.95	3.02	5.05	

DAS – Days After Sowing, \* Mean of three replications, Values in parenthesis are SQRT values - † Values in parenthesis are arc sine values  
 SINPV- *Spodoptera litura* Nuclear Polyhydrosis Virus (Spodo-cide 0.50% AS, 1X10<sup>9</sup> POB/ml, make - PCI) - *Beauveria bassiana* – Toxin 1.15% WP, make- Varsha Bioscience & Technology - *Bt.k* – *Bacillus thuringiensis* Serovar Kurstaki H 3a, 3b, 3c; 5% WP, Halt, 5X10<sup>7</sup> spore/mg, make - Biostadt - NSKE – Neem Seed Kernel Extract - In a column, means followed by a common letter (s) are not significantly different by DMRT (P=0.05)

**Table 2. Effect of different biological control practices in suppression of tobacco caterpillar, *Spodoptera litura* (Fab.) in Groundnut (Pooled data of Kharif 2012, Kharif, 2013 and Kharif, 2014)**

Treatments	*Mean no. of leaf miner larvae / plant											% reduction over control†
	One day before first spray	Days after first spray (30 DAS)			One day before second spray	Days after second spray (55 DAS)			Mean of two sprays			
		3 <sup>rd</sup> day	5 <sup>th</sup> day	10 <sup>th</sup> day		3 <sup>rd</sup> day	5 <sup>th</sup> day	10 <sup>th</sup> day				
										3 <sup>rd</sup> day	5 <sup>th</sup> day	
Release of <i>Trichogramma chilonis</i> @ 1,00,000 ha <sup>-1</sup> at 30 & 55 DAS	2.61 (1.76)	1.93 (1.56) <sup>ab</sup>	2.07 (1.61) <sup>a</sup>	1.97 (1.56) <sup>b</sup>	2.41 (1.71)	1.80 (1.52) <sup>ab</sup>	1.97 (1.56) <sup>b</sup>	2.10 (1.62) <sup>b</sup>	1.97 (1.58) <sup>b</sup>	26.20 (30.74) <sup>d</sup>		
<i>Bt.k</i> (Halt 5%WP) @ 1.5 kg ha <sup>-1</sup> at 30 DAS & 55 DAS	2.49 (1.72)	1.73 (1.49) <sup>bc</sup>	1.50 (1.41) <sup>b</sup>	2.37 (1.68) <sup>b</sup>	2.09 (1.60)	1.30 (1.33) <sup>bc</sup>	1.43 (1.39) <sup>bc</sup>	1.97 (1.57) <sup>b</sup>	1.72 (1.49) <sup>c</sup>	5.66 (36.61) <sup>c</sup>		
<i>Bt.k</i> (Halt 5%WP) @ 1 kg ha <sup>-1</sup> at 30 DAS and SINPV @ 250 LE ha <sup>-1</sup> at 55 DAS	2.33 (1.68)	1.47 (1.40) <sup>bc</sup>	1.27 (1.33) <sup>bc</sup>	1.23 (1.30) <sup>c</sup>	1.98 (1.58)	1.27 (1.33) <sup>bc</sup>	1.17 (1.28) <sup>cd</sup>	1.90 (1.55) <sup>b</sup>	1.38 (1.37) <sup>d</sup>	47.96 (43.80) <sup>b</sup>		
NSKE @ 5% at 30 & 55 DAS	3.02 (1.87)	1.23 (1.31) <sup>cd</sup>	1.07 (1.26) <sup>c</sup>	1.03 (1.24) <sup>c</sup>	1.97 (1.57)	0.60 (1.04) <sup>d</sup>	0.67 (1.06) <sup>d</sup>	1.17 (1.28) <sup>c</sup>	0.96 (1.20) <sup>e</sup>	4.02 (53.16) <sup>a</sup>		
<i>Beauveria bassiana</i> @ 2.5 kg ha <sup>-1</sup> at 30 DAS & 55 DAS	2.84 (1.82)	1.37 (1.37) <sup>cd</sup>	1.20 (1.30) <sup>bc</sup>	1.17 (1.29) <sup>c</sup>	2.17 (1.63)	1.33 (1.34) <sup>bc</sup>	1.37 (1.37) <sup>bc</sup>	1.87 (1.53) <sup>b</sup>	1.38 (1.38) <sup>d</sup>	8.18 (43.95) <sup>b</sup>		
<i>Beauveria bassiana</i> @ 2 kg ha <sup>-1</sup> at 30 DAS and SINPV @ 250 LE ha <sup>-1</sup> at 55 DAS	2.10 (1.62)	1.27 (1.33) <sup>cd</sup>	1.20 (1.30) <sup>bc</sup>	1.10 (1.27) <sup>c</sup>	1.96 (1.57)	1.03 (1.23) <sup>cd</sup>	1.27 (1.33) <sup>bcd</sup>	1.77 (1.51) <sup>b</sup>	1.27 (1.34) <sup>d</sup>	2.31 (46.32) <sup>b</sup>		
Quinalphos 25 EC @ 1 l ha <sup>-1</sup> at 30 DAS & 55 DAS	2.77 (1.80)	0.97 (1.21) <sup>d</sup>	0.93 (1.19) <sup>c</sup>	1.00 (1.23) <sup>c</sup>	1.97 (1.57)	0.70 (1.09) <sup>d</sup>	1.20 (1.30) <sup>bcd</sup>	1.13 (1.28) <sup>c</sup>	0.99 (1.22) <sup>e</sup>	2.87 (52.49) <sup>a</sup>		
Untreated Check	2.69 (1.78)	2.40 (1.70) <sup>a</sup>	2.30 (1.67) <sup>a</sup>	3.43 (1.97) <sup>a</sup>	2.59 (1.76)	2.33 (1.69) <sup>a</sup>	3.00 (1.86) <sup>a</sup>	2.60 (1.76) <sup>a</sup>	2.68 (1.79) <sup>a</sup>	0.00 (1.62) <sup>e</sup>		
<b>CD (P ≤ 0.05)</b>	NS	0.18	0.14	0.20	NS	0.19	0.28	0.15	0.07	4.06		
<b>CV%</b>	10.61	7.23	6.15	8.23	5.22	8.61	11.56	5.50	2.88	6.00		

DAS – Days After Sowing, \* Mean of three replications, Values in parenthesis are SQRT values - † Values in parenthesis are arc sine values SINPV-*Spodoptera litura* Nuclear Polyhedrosis Virus (Spodo-cide 0.50% AS, 1X10<sup>8</sup> POB/ml, make - PCI) - *Beauveria bassiana* – Toxin 1.15% WP, make-Varsha Bioscience & Technology - *Bt.k* – *Bacillus thuringiensis* Serovar Kurstaki H 3a, 3b, 3c; 5% WP, Halt, 5X10<sup>7</sup> spore/mg, make - Biostadt - NSKE – Neem Seed Kernel Extract - In a column, means followed by a common letter (s) are not significantly different by DMRT (P=0.05)

**Table 3. Yield and economics of different biological control practices imposed against leaf miner and tobacco caterpillar in groundnut (Pooled data of Kharif 2012, Kharif, 2013 and Kharif, 2014)**

Treatments	Pod yield(kg ha <sup>-1</sup> )	Haulms(kg ha <sup>-1</sup> )	Additional pod yield over control (kg ha <sup>-1</sup> )	Cost of treatment with labour charges ( ha <sup>-1</sup> )	Additional returns ( ha <sup>-1</sup> )	Net returns ( ha <sup>-1</sup> )	ICBR
Release of <i>Trichogramma chilonis</i> @ 1,00,000 ha <sup>-1</sup> at 30 & 55 DAS	1804 (42.48) <sup>e</sup>	3943 (62.80) <sup>c</sup>	420	1000	14700	13700	14.7
<i>Bt.k</i> (Halt 5%WP) @ 1.5 kg ha <sup>-1</sup> at 30 & 55 DAS	1977 (44.46) <sup>d</sup>	4237 (65.03) <sup>bc</sup>	593	1360	20755	19395	15.3
<i>Bt.k</i> (Halt 5%WP) @ 1 kg ha <sup>-1</sup> at 30 DAS and SINPV @ 250 LE ha <sup>-1</sup> at 55 DAS	2057 (45.35) <sup>cd</sup>	4448 (66.70) <sup>abc</sup>	673	2210	23555	21345	10.7
NSKE @ 5% at 30 DAS & 55 DAS	2510 (50.09) <sup>a</sup>	4833 (69.52) <sup>a</sup>	1126	2110	39410	37300	18.7
<i>Beauveria bassiana</i> @ 2.5 kg ha <sup>-1</sup> at 30 DAS & 55 DAS	2119 (46.03) <sup>bc</sup>	4499 (67.07) <sup>ab</sup>	735	2160	25725	23565	11.9
<i>Beauveria bassiana</i> @ 2 kg ha <sup>-1</sup> at 30 DAS and SINPV @ 250 LE ha <sup>-1</sup> at 55 DAS	2228 (47.20) <sup>b</sup>	4625 (67.95) <sup>ab</sup>	844	2610	29540	26930	11.3
Quinalphos 25 EC @ 1 l ha <sup>-1</sup> at 30 DAS & 55 DAS	2570 (50.69) <sup>a</sup>	4947 (70.22) <sup>a</sup>	1186	2160	41510	39350	19.2
Untreated Check	1384 (37.20) <sup>f</sup>	3289 (57.34) <sup>d</sup>	—	—	—	—	—
<b>CD (P ≤ 0.05)</b>	1.43	4.24					
<b>CV%</b>	1.79	3.68					

Values in Parenthesis are SQRT values

Figures followed by the same letter did not differ significantly

under glasshouse and field conditions (Senthilraja *et al.*, 2010).

### Evaluation of biopesticides against tobacco caterpillar

The larval population of *S. litura* one day before first sprayings ranged from 2.10 larvae plant<sup>-1</sup> to 3.02 larvae plant<sup>-1</sup> and it was uniform across the treatments as indicated by non-significant difference between treatments. At three days after first spraying, quinalphos (chemical check) showed its superiority in recording lowest larval population (0.97 plant<sup>-1</sup>) of *S. litura* significantly followed by NSKE 5% and two doses of *B. bassiana* treated plots (1.23 larvae plant<sup>-1</sup>, 127 larvae plant<sup>-1</sup> and 1.37 larvae plant<sup>-1</sup>, respectively). The untreated check recorded highest population of 2.40 larvae plant<sup>-1</sup> and at par with *T. chilonis* released plots (1.93 larvae plant<sup>-1</sup>). At five days after first spraying, there was no significant difference among the treatments in the larval population except standard check quinalphos and NSKE 5% which registered 0.93 larvae plant<sup>-1</sup> and 1.07 larvae plant<sup>-1</sup>, respectively. *B. bassiana* @ 2.0 kg ha<sup>-1</sup> and 2.5 kg ha<sup>-1</sup> and *Bt.k* @ 1.5 kg ha<sup>-1</sup> were next in the order of efficacy with at par larval populations of 1.20 larvae plant<sup>-1</sup> and 1.27 larvae plant<sup>-1</sup>, respectively. At 10 days after first spraying, the chemical check, quinalphos (1.00 larvae plant<sup>-1</sup>) and NSKE 5% (1.03 larvae plant<sup>-1</sup>) maintained their superiority in recording lowest larval population of *S. litura* and were at par with two doses of *B. bassiana* @ 2.0 kg ha<sup>-1</sup> and 2.5 kg ha<sup>-1</sup> (1.10 larvae plant<sup>-1</sup> and 1.17 larvae plant<sup>-1</sup>, respectively).

Pre-treatment population count during second spraying ranged from 1.96 larvae plant<sup>-1</sup> to 2.59 larvae plant<sup>-1</sup> with no statistical difference among the treatments. Three days after second spraying, NSKE 5% recorded lower larval population of 0.60 per plant, being at par with quinalphos (0.77 larvae plant<sup>-1</sup>), SINPV @ 250 LE ha<sup>-1</sup> (1.03 larvae plant<sup>-1</sup>), and differed significantly with the remaining treatments. Two dosages of *Bt.k* @ 1.0 kg ha<sup>-1</sup> and

1.5 kg ha<sup>-1</sup> and *B. bassiana* @ 2.5 kg ha<sup>-1</sup> (1.27 larvae plant<sup>-1</sup>, 1.30 larvae plant<sup>-1</sup> and 1.33 larvae plant<sup>-1</sup>, respectively) were at par with each other and were significantly different with untreated check (2.33 larvae plant<sup>-1</sup>). A similar trend of treatment difference was observed after five and ten days of treatment imposition. NSKE 5% and quinalphos maintained their superiority even after 10 days of second spray. Similarly, SINPV was the next best in the second round of treatment imposition, followed by *B. bassiana* @ 2.5 kg ha<sup>-1</sup>. The remaining treatments supported comparatively higher larval population of *S. litura* (Table 2).

The overall mean larval populations of *S. litura* after two sprayings was significantly reduced by NSKE 5% (0.96 larvae plant<sup>-1</sup>) and quinalphos (0.99 larvae plant<sup>-1</sup>) compared with biopesticide sprays. Spray schedule comprising *B. bassiana* @ 2.0 kg ha<sup>-1</sup> at 30 DAS followed by second spray of SINPV at 55 DAS recorded comparatively lower *S. litura* population (1.27 larvae plant<sup>-1</sup>) and was at par with two sprays of *B. bassiana* @ 2.5 kg ha<sup>-1</sup> and one spray of *Bt.k* @ 1.0 kg ha<sup>-1</sup> at 30 DAS followed by second spray of SINPV at 55 DAS recorded identical population of 1.38 larvae plant<sup>-1</sup>. Two sprays of *Bt.k* @ 1.5 kg ha<sup>-1</sup> (1.72 larvae plant<sup>-1</sup>) and release of *T. chilonis* twice (1.97 larvae plant<sup>-1</sup>) at 30 DAS and 55 DAS did not exert much reduction of *S. litura* larval population but has significantly differed from untreated check (2.68 larvae plant<sup>-1</sup>). Similar trend was also observed in % reduction in larval population of *S. litura* over control which was significantly highest in plots received two scheduled sprays of NSKE 5% (64.0%) and quinalphos (62.9%) followed by first spray of *B. bassiana* at 30 DAS and second spray of SINPV at 55 DAS (52.3%) which was at par with two sprays of *B. bassiana* (48.2%) at 30 DAS and 55 DAS and one spray of *Bt.k* at 30 DAS and second spray of SINPV at 55 DAS (47.9%). Lowest % reduction in larval population of *S. litura* over control was recorded in tricho cards pinned plots (26.2%)

and has significantly differed from two sprays of *Bt.k* @ 1.5 kg ha<sup>-1</sup> (35.7%).

Field experiments have shown that 15% neem leaf extract and neem seed extract (Koshiya and Ghelani, 1993; Nandagopal and Ghewande, 2004), neem seed kernel extract (Raman *et al.*, 2000), neem based insecticide, Repellin (Obulapathi *et al.*, 2000) and 1% neem oil (Bhanukiran *et al.*, 1997) reduced *S. litura* damage on foliage of groundnut resulting in higher pod yields. The reported effectiveness of SINPV against *S. litura* is in line with the results reported by Dhandapani and Babu (1995). Similarly, Mabrouk and Abbas (2002), Basappa and Singh (2003), Kumari and Singh (2009) and Ali *et al.* (2011) reported that the virulence of SINPV proved most effective against *S. litura* larval population. The said efficacy of *B. bassiana* is in line with Sahayaraj and Namachivayam (2011) who observed great reduction in infestation of *S. litura* after the treatment of *B. bassiana* and subsequent increase in yield (1721.31 kg ha<sup>-1</sup>) and cost-benefit ratio (1: 1.93). Fungi have considerable epizootic potential and spread quickly through the insect population (Tanada and Kavaya, 1993). In the study area, fully mycosed larvae of *S. litura* and *A. modicella* were observed 15 days to 20 days after the treatment of *B. bassiana*. The spores from this dead cadavers might be carried away by the wind and caused further infection and enhanced the fungal activity. The treatment schedule comprising two sprays of *Bt.k* @ 1.5 kg ha<sup>-1</sup> at 30 DAS and 55 DAS was found least effective which caused the minimum reduction of larval population of *S. litura* is in tune with the results reported by Jat *et al.* (2017).

Pod yield has significantly ranged from 1384 kg ha<sup>-1</sup> to 2570 kg ha<sup>-1</sup> across the treatments. Highest pod yield of 2570 kg ha<sup>-1</sup> was recorded in quinalphos treatment and it was at par with NSKE 5% (2510 kg ha<sup>-1</sup>), both are significantly superior over all the other treatments. This was followed by first spray of *B. bassiana* and subsequent spray of SINPV (2228 kg

ha<sup>-1</sup>). Two scheduled sprays of *B. bassiana* (2119 kg ha<sup>-1</sup>) were at par with earlier treatment and also with first spray of *Bt.k* and subsequent spray of SINPV (2057 kg ha<sup>-1</sup>). The latter treatment was at par with two sprays of *Bt.k* (1977 kg ha<sup>-1</sup>). Whereas, lowest pod yield of 1804 kg ha<sup>-1</sup> was recorded in *T. chilonis* released plots and differed significantly from untreated check. Similarly, significantly highest haulm yield was recorded by quinalphos (4947 kg ha<sup>-1</sup>) and NSKE 5% (4833 kg ha<sup>-1</sup>) which were followed by a spray of *B. bassiana* and subsequent spray of SINPV (4625 kg ha<sup>-1</sup>). The trend of remaining treatments was similar to that of pod yield (Table 3).

Considering the Incremental Cost-Benefit Ratio (ICBR), quinalphos registered the highest incremental benefit of 41510 ha<sup>-1</sup> and ICB ratio of 19.2. This was followed by NSKE 5% which recorded 39410 ha<sup>-1</sup> of incremental benefit with ICB ratio of 18.7. Although, two scheduled sprays of *Bt.k* and release of *T. chilonis* parasitoid recorded significantly low yields in the investigation, due to involvement of less treatment cost, they could record higher ICBR of 15.3 and 14.7, respectively. While two sprays of *B. bassiana* and one spray of *B. bassiana* followed by SINPV recorded lower ICB ratio of 11.9 and 11.3, respectively and treatment schedule comprising one spray of *B. bassiana* followed by SINPV recorded lowest ICB ratio of 10.7 (Table 3).

## CONCLUSION

The botanicals such as neem and biopesticides based on *Bt.k*, NPV viruses and hyphomycetous entomopathogenic fungi, *B. bassiana* have been used to target insect pests for over years. This study revealed that the NSKE 5% treatment distinctly decreased the *A. modicella* and *S. litura* larval populations and their infestation on groundnut with higher yield and cost-benefit ratio. Among the biopesticides, two scheduled sprays of *B. bassiana* and *Bt.k* were effective in checking *A. modicella* incidence, while, scheduled spray of *B. bassiana* followed by SINPV demonstrated their

efficacy during first and second sprays, respectively by recording lower *S. litura* population and also by registering higher yield. It is, thus, concluded that the use of NSKE and *B. bassiana* in groundnut would become biological alternatives to insecticides for the control of defoliators.

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## VARIABILITY AND GENETIC PARAMETERS FOR DIFFERENT YIELD CONTRIBUTING TRAITS IN GRAIN AMARANTH

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### ABSTRACT

Twenty- seven genotypes of grain amaranth were used to study nature and genetic parameters with an aim to select superior genotypes. Phenotypic variance was higher than the genotypic variance for all the traits. The heritability estimates for all the characters were high and none of the characters showed moderate or low estimates. Days to maturity got significant positive correlation with seed yield, plant height, length of inflorescence and 10 ML seed weight (g). Plant height was also found to have significant positive correlation with seed yield and 10 ML seed weight. Length of inflorescence and 10 ML seed weight had significant and positive correlation with yield. In case of path analysis, days to maturity had direct effects on grain yield than 10 ML seed weight, length of inflorescence and plant height. For the cluster analysis, 27 genotypes were grouped into four clusters in which third cluster was higher than other in terms of cluster mean. Lower cluster mean belonged to fourth cluster.

### INTRODUCTION

The genus *Amaranthus* includes approximately 60 species (National Academy of Sciences, 1984), most of which are widely dispersed weeds. It is closely linked with the life and culture of rural people as the seeds are used in various forms of preparations. Amaranth grain has protein of an unusually high quality (high in the amino acid lysine 5.0% to 6.0 % and also rich in the sulphur-containing amino acids) that confirms its high potential for use in both human and animal nutrition and also shows high promise for supplementing nutritive food and amelioration of protein deficiency strictly in the vegetarian diet people (Andrasofszky *et al.*, 1998). In India, *A. hypochondriacus* L. is often popped to be used in confections. In Nepal, amaranth seeds are eaten as a gruel called “*sattoo*” or milled into a flour to make *chappati*. (Singhal and Kulkami, 1988).

A range of plant breeding methods can be used for the improvement of this self-pollinated and cross pollinated crop (Jain *et al.*, 1986 and Kulokow and Jain, 1987). In order to meet the superior genotypes for yield under sandy loam soil condition, development of high yielding genotypes with desirable

agronomic traits for such ecosystem is therefore a necessity. The systematic approach for developing superior varieties in any crop depends mainly on selecting desirable genotypes and parent for development of crosses. The scope for improvement of amaranthus is mainly based on the extent of genotypic and phenotypic variability present in the material. There will be greater chances of producing a desired type with more variability. Selection based on the phenotype would be difficult for polygenic traits. Knowledge of correlation between yield and its contributing characters is basic need to find out guidelines for plant selection. Partitioning of total correlation into direct and indirect effect by path coefficient analysis helps in making the selection more effective (Priya and Joel, 2009). Knowledge about the nature and magnitude of associations of yield with various component characters is a prerequisite to bring improvement in the desired direction. Therefore, the objective of the study was to investigate the genetic parameter and association between grain yield and yield contributing traits as a basis for selection of high yielding amaranthus genotype for Northern Hill Zone of Chhattisgarh.

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## MATERIAL AND METHODS

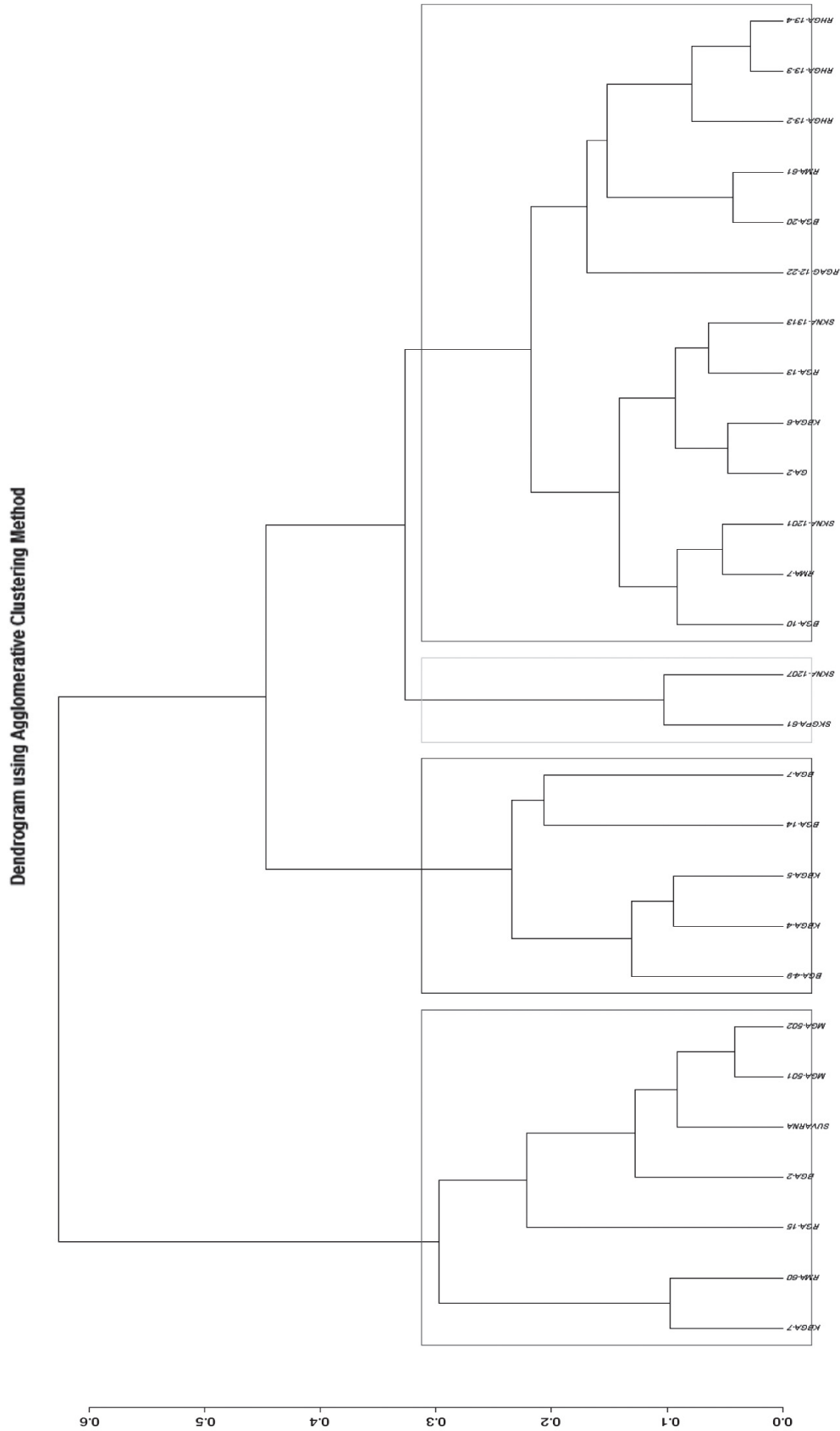
Field experiment was carried out at *Raj Mohini Devi* College of Agriculture and Research Station, Ambikapur during *Rabi* season of 2017-18. Twenty-eight genotypes (BGA-4-9, KBGA-4, KBGA-5, BGA-14, BGA-7, BGA-10, SKGPA-61, SKNA-1207, RGA-13, RGA-15, RGAG-12-22, RHGA-13-2, RHGA-13-3, RHGA-13-4, BGA-10, BGA-20, SKNA-1201, SKNA-1313, MGA-501, MGA-502, RMA-60, RMA-61, KBGA-6, KBGA-7) along with four national checks (SUVARNA, BGA-2, RMA-7 and GA-2) were selected from All India Coordinated Research Network (AICRN) on potential crops. The experiment was laid out in a randomized block design and all the recommended package of practices were provided for good crop growth and development. All the plants of each genotype from each replication were used for recording of characters such as days to 50% flowering, plant height, length of inflorescence, days to maturity, 10 ML seed weight (g) and yield (q ha<sup>-1</sup>.) The data was analysed as per the procedure of Singh and Chowdhary (1985).

## RESULTS AND DISCUSSION

A wide range was observed for most of the characters. The heritability estimates for all the characters were high and none of the characters showed moderate or low. The heritability (broad sense) estimates ranged between 90 days to 98 days for maturity for 10 ML seed weight. The heritability estimates for all the characters were high. Maximum heritability estimate was observed for 10 ML seed weight followed by days to 50% flowering and plant height. Improvement for such characters is easy. Phenotypic variance was higher than the genotypic variance for all the traits. Genotypic coefficients of variation ranged from 5.5 (plant height) to 21.75 (10 ML seed weight) and for phenotypic variance, the minimum value was recorded for plant height (5.65) and maximum for 10 ML seed weight (21.87). According to Siva Subramanin and Menon (1973), GCV and PCV were categorized as: < 10 % is low,

10-20 % is moderate and >20 % is high. Pawar (1995) observed higher estimation of GCV and PCV for number of branches plant<sup>-1</sup> followed by grain yield plant<sup>-1</sup> and leaf area plant<sup>-1</sup> in grain amaranthus. Lohitswa *et al.* (1996) reported considerable amount of phenotypic and genotypic variability for fresh weight. Variability is the most important characteristic feature of any population. Estimation of variability is an important prerequisite for realizing the response to selection as the progress in the breeding depends upon its amount, nature and magnitude. The genetic proportion of this variability measured in terms of genotypic coefficient of variation (GCV) alone represents the heritable component of total variability. Higher the GCV, greater will be the chance for exploitation of that particular character in a selection programme. The genetic variability in terms of GCV alone is not sufficient for determination of amount of heritable variability. In addition, estimation of heritability and genetic advance as percent of mean is also needed to assess the extent of genetic gain expected from effective selection. As heritability in broad sense includes both additive and epistatic gene effects, it will be reliable only when it is accompanied with high genetic advance (Johnson *et al.*, 1955).

The genotypic correlation is higher than the phenotypic correlation for all the traits. It indicates there is strong association between these two characters genetically but the phenotypic value is lessened by the significant interaction of environment. Days to 50 per cent flowering was not found to be significantly correlated with yield and any other traits. Days to maturity has significant positive correlation with fruit yield, plant height, length of inflorescence and 10 ML seed weight. Plant height had significant positive correlation with fruit yield and 10 ML seed weight. Length of inflorescence and 10 ML seed weight were also having significant and positive correlation with yield. The findings indicated that plants with more plant height, length of inflorescence and 10 ML seed weight tend to have



**Fig. 1. Dendrogram diversity relationship among 27 genotypes of amaranth in four clusters based on Mahalanobis  $D^2$  values**

**Table 1. Genetic parameters of variation in Amaranth**

Characters	Mean	Range		Coefficient of variation		Heritability (h <sup>2</sup> %)	Genetic Advance
		Minimum	Maximum	Phenotypic	Genotypic		
Days to 50% flowering	70.93	57.00	90.00	12.75	12.57	97	25.51
Days to Maturity	102.02	78.47	139.00	16.00	15.25	90	29.70
Plant height (cm)	122.22	116.33	136.33	5.65	5.50	94	10.96
Length of inflorescence (cm)	55.67	32.73	80.33	21.27	20.62	93	40.80
10 ML seed weight (g)	6.82	4.23	9.80	21.87	21.75	98	43.97
Yield (q ha <sup>-1</sup> )	18.17	15.30	24.73	14.45	13.98	93	27.72

**Table 2. Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficient between yield and its components in amaranth**

Character	Days to 50% flowering	Days to maturity	Plant height (cm)	Length of inflorescence (cm)	10 ML seed weight (g)	Yield (q/ha)
Days to 50% flowering	<b>1.00</b>	0.20	0.33	0.28	0.08	0.072
Days to Maturity	0.20	<b>1.00</b>	0.59**	0.64**	0.63**	0.76**
Plant height (cm)	0.32	0.54**	<b>1.00</b>	0.23	0.75**	0.56**
Length of inflorescence (cm)	0.26	0.61**	0.22	<b>1.00</b>	0.11	0.47*
10 ML seed weight (g)	0.08	0.59**	0.73**	0.10	<b>1.00</b>	0.65**
Yield (q ha <sup>-1</sup> )	0.06	0.71**	0.52**	0.46*	0.63**	<b>1.00</b>

\* 5% level of significance; \*\* 1% level of significance

**Table 3. Direct and indirect effect of component character on grain yield in amaranth**

Character	1	2	3	4	5
1	<b>-0.11</b>	0.08	0.01	0.05	0.03
2	-0.02	<b>0.41</b>	0.03	0.12	0.21
3	-0.03	0.24	<b>0.05</b>	0.04	0.25
4	-0.03	0.26	0.01	<b>0.19</b>	0.03
5	-0.01	0.26	0.04	0.02	<b>0.33</b>

Residual = 0.5859

**Table 4. Cluster of genotypes accession with their composition**

Cluster	Number of genotypes	Cluster members
I	13	BGA-10, BGA-20, GA-2, KBGA-6, RGA-13, RGAG-12-22, RHGA-13-2, RHGA-13-3, RHGA-13-4, RMA-61, RMA-7, SKNA-1201 and SKNA-1313
II	5	BGA-14, BGA-4-9, BGA-7, KBGA-4 and KBGA-5
III	7	BGA-2, KBGA-7, MGA-501, MGA-502, RGA-15, RMA-60 and SUVARNA
IV	2	SKGPA-61 and SKNA-1207

high seed yield, thereby, increasing seed yield (Table 2).

The several groups of genotypes configuration may admit a description in terms of a few group constellations and their interrelationship. Mahalanobis (1936) distance statistic ( $D^2$ ) is useful tool and is now well established and widely used in plant breeding for classifying the genetic stocks, on the basis of genetic divergence between populations. Cluster analysis of 27 grain amaranthus genotypes based on six quantitative traits (Fig. 1) was carried out and genotypes were grouped into four clusters. First cluster with 13 genotypes is the largest cluster and included BGA-10, BGA-20, GA-2, KBGA-6, RGA-13, RGAG-12-22, RHGA-13-2, RHGA-13-3, RHGA-13-4, RMA-61, RMA-7, SKNA-1201 and SKNA-1313 genotypes and followed by third cluster with seven

genotypes include BGA-2, KBGA-7, MGA-501, MGA-502, RGA-15, RMA-60 and SUVARNA, cluster two with five genotypes namely BGA-14, BGA-4-9, BGA-7, KBGA-4 and KBGA-5 and fourth cluster with two genotypes SKGPA-61 and SKNA-1207. In this study, 27 genotypes were examined in order to calculate cluster mean comparing all four clusters (Table 3). Third cluster was higher than the other three clusters in terms of mean comparison. Lowest mean was recorded in fourth cluster. Greater is the reduction in differences between cluster distances, higher close proximity of genotypes is present in those clusters.

Path analysis is used to describe the directed dependencies among a set of variables which is carried out to estimate the direct and indirect contribution of various component traits for

recommending a reliable selection criteria revealed that days to maturity (0.41) followed by 10 ML seed weight (0.33) length of inflorescence (0.19) and plant height (0.05) had direct effects on grain yield (Table 4). In the study, the characters such as plant height, and panicle length and seed weight showed significantly positive association with grain yield. Therefore, these characters might be considered for improving grain yield in grain amaranth.

## CONCLUSION

Grain amaranth has huge variation for selected traits along with high heritability. Therefore, these characters are utilized for development of new recombinants for early maturing and high yielding segregants with good quality traits and these important characters will decide the future of Amaranth. The dendrogram indicated presence of considerable heterogeneity in examined amaranth genotypes. Genotypes from different group represent a solid base for further breeding program.

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## ELEMENTAL COMPOSITION AND MOLAR RATIOS OF SOILS OF THOTAPALLI IRRIGATION PROJECT IN NORTH COASTAL ANDHRAPRADESH

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### ABSTRACT

The study on chemical composition of soils under Thotapalli irrigation project was carried out during 2018. The soils of study area were developed from granite-gneiss to calcareous murrum mixed granite-gneiss parent material. Total silica ( $\text{SiO}_2$ ) of soils ranged from 48.1% to 71.4 %. Silica content in general decreased with soil depth, while sesquioxides ( $\text{R}_2\text{O}_3$ ), alumina ( $\text{Al}_2\text{O}_3$ ), iron oxide ( $\text{Fe}_2\text{O}_3$ ), CaO,  $\text{K}_2\text{O}$ ,  $\text{Na}_2\text{O}$ , MnO were found increasing with depth. High silica/sesquioxide ratio of soils indicate siliceous nature of soils. The aluminum oxide content of the profiles varied from 15.2% to 22.9%. Highest value was reported in Devarapalli profile, whereas, the lowest value was recorded in Maddivalasa profile. Iron oxide content varied from 3.60 to 12.8 per cent. Iron oxide content showed slight variation within profiles and greater variation among profiles. Among other oxides,  $\text{CaO} > \text{MgO} > \text{K}_2\text{O} > \text{Na}_2\text{O}$  is in the order. Because of the semiarid climate under which the soils were developed, and due to limited leaching the basic cation might have accumulated in these soil profiles. Silica was positively correlated with sand content ( $r = +0.537^{**}$ ), whereas, salumina ( $\text{Al}_2\text{O}_3$ ) content was negatively correlated with  $\text{SiO}_2$  ( $r = -0.296^*$ ) and sand content ( $r = -0.351^*$ ). The molar concentration of silica ( $\text{SiO}_2$ ) ranged from 0.802 to 1.19 moles, and molar concentration of sesquioxide ranged from 0.173 to 0.275 moles. The molar ratio of  $\text{SiO}_2 / \text{R}_2\text{O}_3$  varied from 3.74 to 6.59 in different soil profiles. The  $\text{SiO}_2 / \text{Al}_2\text{O}_3$  ratio varied from 4.43 to 7.65. These wider molar ratios indicate salacious nature of parent material and dominance of silica among chemical fraction.

### INTRODUCTION

Soils are the products of chemical, biochemical and physical processes that took place on parent material over a period of time. The chemical composition of the soils reflects the land form, climate, nature of parent material and intensity of weathering (Pal and Sarma, 2000). Nearly 90% of the mineral matter of most of the soils consists of the combined oxides of silicon, aluminium and iron, while the oxides of calcium, magnesium, sodium and potassium together constitute 5% to 7% (ISSS, 2002). The elemental composition of soil also reveals the constituent minerals and nutrient supplying capacity of soils. The soils under Thotapalli irrigation project in North Coastal Andhra Pradesh developed from granite-gneiss and calcareous murrum combined granite-gneiss were not studied earlier for their elemental composition.

### MATERIAL AND METHODS

The study area was located between  $18^\circ 12' 820''$  to  $18^\circ 32' 876''$  N latitude and  $83^\circ 29' 889''$  to  $83^\circ 37' 727''$  E longitudes covering 1.36 lakh acres under ayacut constituting parts of Srikakulam and Vizianagaram districts of North Coastal agro climatic zone of Andhra Pradesh. The climate is semi-arid monsoon type with alternate wet and dry seasons as evidenced by past one decade meteorological data from 2008 to 2017. The mean annual temperature and rain fall were  $28.34^\circ\text{C}$ , 950.8 mm and  $26.48^\circ\text{C}$ , 1108.7mm in Vizianagaram and Srikakulam districts, respectively. The reconnaissance soil survey was conducted in the ayacut area of Thotapalli major irrigation canal during April, 2018 to June, 2018 using topo sheets of 1: 50,000 scale as per the procedure outlined by AIS&LUS (1970). Auger bores, mini pits, road cuts of 15 profiles located on uplands and plains were

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studied. Six representative soil profiles were exposed and horizon-wise soil samples were collected. Soil samples were processed and passed through a two mm sieve and the fine earth fraction was analyzed for elemental composition by following standard procedure as described by Hesse (1971) and Jackson (1973). Molar concentrations and molar ratios were computed from the elemental composition (Table 1 and Table 2).

## RESULTS AND DISCUSSION

The particle size distribution of the six profiles studied varied among the profiles and within the profile. Sand, silt and clay contents ranged from 37.3% to 76.5%, 10.4% – 18.9 % and 12.6% to 45.2%, respectively (Table 1). The total silica ( $\text{SiO}_2$ ) content of profiles ranged from 45.10% to 71.40 % (Table 1), hence, these soils are considered as siliceous in nature and did not follow any regular trend in silica content with depth. Soils with relatively coarse texture (pedons 1,2 3 and 5) are dominated mostly by sand fraction hence showed more silica content. It was also found positive correlation ( $r = +0.537^{**}$ ) with total sand content. Ramalakshmi *et al.* (2001) also reported positive correlation between silica and sand content in soils of Bapatla Karlapalem region of Guntur district in Andhra Pradesh. Sesquioxide ( $\text{R}_2\text{O}_3$ ) content ranged from 19.01% to 32.4 per cent. Profile 2 had recorded highest value of 32.4 in lower horizon and the lowest value of 19.01 per cent was noticed in Ap horizon of profile 6. The variations in sesquioxide content might be due to the kind of parent material, physiography, soil drainage and overall pedo-chemical environment. Ram Prakash and Seshagiri Rao (2002) also reported wide range of sesquioxide ( $\text{R}_2\text{O}_3$ ) in some soils of Krishna district of Andhra Pradesh.

The aluminum oxide content of the profiles varied from 15.2% to 23.5 per cent (Table 1). Highest value was reported in *Patikivalasa* profile, whereas, the lowest value was recorded in *Maddivalasa* profile. Irregular trend of alumina with depth was observed

throughout the profiles. Aluminum oxide being the major fraction of the sesquioxides, hence, followed the pattern of sesquioxides distribution. Vertisols of Rajasthan also exhibited irregular trend of alumina in soil profiles as reported by Singh *et al.* (2001). Among different profiles, the iron oxide content varied from 3.60 % to 12.8% and showed slight variation within a profiles and greater variation among profiles, which is attributed to variation in clay content and chemical composition of primary and secondary minerals. Gurumurthy *et al.* (1996) and Ramprakash and Seshagiri Rao (2002) also reported slight variations of iron oxide within profile and greater variations among the soil profiles of Giddalur mandal of Prakasam dsitric and some selected soils of Krishna district of Andhra Pradesh, respectively. The alumina ( $\text{Al}_2\text{O}_3$ ) content was negatively correlated with  $\text{SiO}_2$  ( $r = -0.296^*$ ) and sand content ( $r = -0.351^*$ ) and the finding was similar to Choudhari (1988). Among other oxides,  $\text{CaO} > \text{MgO} > \text{K}_2\text{O} > \text{Na}_2\text{O}$  is in the order. Calcium oxide content ranged from 0.32% to 5.5% and found increasing trend with soil depth. MgO content ranged from 0.16 to 1.05 percent and found increased with soil depth. Because of semi-arid climate under which the soils were developed and due to limited leaching the basic cation might have accumulated in these soil profiles. Gurumurthy *et al.* (1996) reported the order of dominance of oxides as  $\text{SiO}_2 > \text{Al}_2\text{O}_3 > \text{Fe}_2\text{O}_3 > \text{CaO} > \text{MgO} > \text{K}_2\text{O} > \text{Na}_2\text{O}$  in the soils of Giddalur mandal of Prakasam district. Potassium oxide, sodium oxide, manganese oxide, copper oxide and zinc oxide of soils of study area ranged from 0.154- 0.295%, 0.07- 0.159%, 0.049- 0.085%, 21- 53 ppm, 32- 84 ppm, respectively. Potassium oxide, sodium oxide, manganese oxide were found increased with depth, however copper oxide and zinc oxide were higher in the surface horizons and decreased with depth. Similar trend of copper oxide and zinc oxide with soil depth in some selected soils of Krishna district was also reported by Ram Prakash and Seshagiri Rao (2002).

Table 1. Chemical composition of the soils (oxide forms of Si, Al, Fe, Ca, Mg, K, Na, Mn, Cu and Zn)

Profile No. & horizon	Depth (m)	sand %	silt %	clay %	Chemical Composition										
					SiO <sub>2</sub>	R <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	CaO	MgO	K <sub>2</sub> O	Na <sub>2</sub> O	MnO	CuO	ZnO
					%										
<b>1. Devarapalli soil profile : Fine loamy, mixed, iso hyperthermic Typic Haplustalf</b>															
Ap	0.00-0.10	62.2	18.6	19.2	68.00	26.43	19.80	7.63	0.74	0.21	0.19	0.08	0.05	34	54
Bw	0.10-0.25	58.0	17.5	24.5	69.10	26.41	20.10	6.31	0.83	0.33	0.20	0.10	0.05	30	50
Bt1	0.25-0.58	53.5	17.5	29.0	61.60	25.84	19.80	6.04	1.56	0.42	0.19	0.10	0.07	28	42
Bt2	0.58-0.70	56.0	16.0	28.0	66.10	29.05	21.90	7.15	1.67	0.56	0.22	0.12	0.07	25	37
Bt3	0.70-0.90	60.5	15.5	24.0	70.00	27.70	18.10	7.60	1.83	0.61	0.18	0.10	0.06	22	34
Bt4	0.90-1.19+	58.0	17.0	25.0	65.80	29.24	21.90	7.34	1.98	0.69	0.23	0.12	0.08	21	32
<b>2. Gujjangivalasa soil profile: Fine loamy, kaolinitic, iso hyperthermic Typic Haplustults</b>															
Ap	0.00-0.10	76.5	10.9	12.6	71.40	27.80	17.70	10.10	0.32	0.16	0.17	0.09	0.05	38	57
Bw	0.10-0.22	68.0	14.8	17.2	69.20	25.60	16.30	9.30	0.55	0.29	0.16	0.07	0.07	35	48
Bt1	0.22-0.40	69.1	10.4	20.5	61.80	32.10	21.00	11.10	0.72	0.33	0.21	0.09	0.06	31	45
Bt2	0.40-0.70	67.8	11.0	21.2	65.00	30.60	18.30	12.30	0.55	0.21	0.18	0.11	0.07	29	43
Bt3	0.70-0.98+	68.0	11.5	20.5	65.80	32.40	19.60	12.80	0.43	0.29	0.19	0.11	0.05	27	40
<b>3. Patikavalasa soil profile: Fine loamy, mixed, iso hyperthermic Typic Ustochrepts</b>															
Ap	0.00-0.10	61.3	14.4	24.3	65.15	25.41	18.50	6.91	1.20	0.43	0.21	0.14	0.06	41	61
Bw1	0.10-0.30	60.5	13.0	26.5	66.14	26.94	20.90	6.04	2.90	0.45	0.21	0.15	0.09	39	56
Bw2	0.30-0.50	58.2	16.1	25.7	58.25	25.00	19.20	4.80	3.30	0.49	0.20	0.13	0.07	36	52
Bw3	0.50-0.80	59.9	13.6	26.5	59.80	25.93	20.90	5.03	3.50	0.53	0.21	0.16	0.06	34	48
Bw4	0.80-0.95+	63.2	12.5	24.3	56.25	29.01	23.50	5.51	3.80	0.56	0.19	0.16	0.08	30	45

Contd...

Table 1 Contd...

Profile No. & horizon	Depth (m)	sand %	Silt %	clay %	Chemical Composition										
					SiO <sub>2</sub>	R <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	CaO	MgO	K <sub>2</sub> O	Na <sub>2</sub> O	MnO	CuO	ZnO
					%										ppm
<b>4. Gangada soil profile : Clayey , montmorillonitic, iso hyperthermic Vertic Ustochrepts</b>															
Ap	0.00-0.09	55.2	15.8	29.1	54.20	24.10	19.60	4.50	1.50	0.82	0.19	0.11	0.05	51	81
Bw1	0.09-0.40	51.0	14.1	34.9	56.60	22.70	16.60	6.10	2.50	0.89	0.16	0.10	0.06	49	76
Bw2	0.40-0.62	48.1	15.0	36.9	49.20	22.50	18.90	3.60	3.70	0.90	0.24	0.12	0.05	47	69
Bw3	0.62-0.82	53.4	13.2	33.4	52.60	24.01	18.90	5.11	4.00	0.96	0.19	0.11	0.07	44	72
Bw4	0.82-1.02+	54.3	14.1	31.6	45.10	26.03	20.50	5.53	5.50	1.05	0.27	0.15	0.07	41	65
<b>5. Aamiti soil profile : Fine loamy, mixed, iso hyperthermic Typic Ustochrepts</b>															
Ap	0.00-0.16	65.3	13.7	21.0	62.60	22.94	15.60	7.34	0.57	0.22	0.17	0.07	0.08	44	73
Bw1	0.16-0.30	63.2	13.6	23.2	57.10	23.30	15.70	7.60	0.45	0.30	0.15	0.10	0.08	43	70
Bw2	0.30-0.48	58.1	16.6	25.3	62.50	24.70	17.10	7.60	0.65	0.36	0.19	0.07	0.07	41	62
Bw3	0.48-0.70	56.4	18.4	25.2	57.30	25.10	16.80	8.30	0.87	0.43	0.27	0.15	0.06	34	56
Bw4	0.70-0.90+	61.4	15.0	23.6	55.00	27.20	18.30	8.90	0.65	0.45	0.17	0.14	0.07	38	47
<b>6. Maddivalasa soil profile : Clayey, montmorillonitic, iso hyperthermic Chromic Haplustert</b>															
Ap	0.00-0.13	43.0	18.9	38.1	68.40	19.01	15.20	3.81	1.25	0.32	0.19	0.12	0.08	53	84
Bw	0.13-0.32	41.5	17.0	41.5	63.30	22.96	18.60	4.36	1.25	0.38	0.28	0.14	0.07	50	82
Bss1	0.32-0.55	39.0	17.0	44.0	70.50	22.72	16.80	5.92	1.50	0.49	0.27	0.15	0.06	48	78
Bss2	0.55-0.74	39.0	18.9	42.1	59.10	28.04	21.90	6.14	1.76	0.60	0.30	0.13	0.06	44	75
Bss3	0.74-1.15+	37.3	17.5	45.2	57.60	23.03	18.20	4.83	1.85	0.85	0.27	0.16	0.07	42	73

Table 2. Molar concentrations and molar ratios of silica and sesquioxides, alumina and iron oxide

Profile No. & horizon	Depth (m)	Molar concentrations (moles)					Molar ratios			
		SiO <sub>2</sub>	R <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub> /R <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub> /Fe <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub> /Fe <sub>2</sub> O <sub>3</sub>	
<b>1. Devarapalli soil profile : Fine loamy, mixed, iso hyperthermic Typic Haplustalf</b>										
Ap	0.00-0.10	1.12	0.24	0.19	0.05	4.62	5.75	23.4	4.06	
Bw	0.10-0.25	1.15	0.24	0.20	0.04	4.87	5.84	29.1	4.99	
Bt1	0.25-0.58	1.03	0.23	0.19	0.04	4.43	5.29	27.1	5.13	
Bt2	0.58-0.70	1.10	0.26	0.22	0.05	4.25	5.13	24.6	4.80	
Bt3	0.70-0.90	1.17	0.23	0.18	0.05	5.18	6.57	24.5	3.73	
Bt4	0.90-1.19+	1.10	0.26	0.23	0.04	4.25	4.88	32.8	4.71	
<b>2. Gujjangivalasa soil profile: Fine loamy, kaolinitic, iso hyperthermic Typic Haplustults</b>										
Ap	0.00-0.10	1.19	0.24	0.17	0.06	5.03	6.86	18.8	2.74	
Bw	0.10-0.22	1.15	0.22	0.16	0.06	5.29	7.22	19.8	2.74	
Bt1	0.22-0.40	1.03	0.28	0.21	0.07	3.74	5.00	14.8	2.96	
Bt2	0.40-0.70	1.08	0.26	0.18	0.08	4.22	6.04	14.1	2.33	
Bt3	0.70-0.98+	1.10	0.27	0.19	0.08	4.03	5.71	13.7	2.29	
<b>3. Patikavalasa soil profile: Fine loamy, mixed, iso hyperthermic Typic Ustochrepts</b>										
Ap	0.00-0.10	1.05	0.25	0.21	0.04	4.14	4.99	24.3	4.87	
Bw1	0.10-0.30	1.10	0.24	0.21	0.04	4.54	5.38	29.1	5.42	
Bw2	0.30-0.50	1.02	0.21	0.18	0.03	4.90	5.72	34.0	5.94	
Bw3	0.50-0.80	1.00	0.24	0.21	0.03	4.22	4.86	31.6	6.51	
Bw4	0.80- 0.95+	1.02	0.22	0.19	0.03	4.05	4.34	30.1	5.77	

Contd...

Table 2 Contd...

Profile No. & horizon	Depth (m)	Molar concentrations (moles)				Molar ratios			
		SiO <sub>2</sub>	R <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub> /R <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub> /Fe <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub> /Fe <sub>2</sub> O <sub>3</sub>
<b>4. Gangada soil profile : Clayey , montmorillonitic, iso hyperthermic Vertic Ustochrepts</b>									
Ap	0.00-0.09	0.90	0.22	0.19	0.03	4.20	4.70	32.1	6.82
Bw1	0.09-0.40	0.94	0.20	0.16	0.04	4.69	5.80	24.7	4.26
Bw2	0.40-0.62	0.82	0.21	0.19	0.02	3.95	4.43	36.4	8.22
Bw3	0.62-0.82	0.88	0.22	0.19	0.03	4.03	4.73	27.4	5.79
Bw4	0.82-1.02+	0.80	0.20	0.17	0.03	4.01	4.27	28.3	6.05
<b>5. Aamiti soil profile : Fine loamy, mixed, iso hyperthermic Typic Ustochrepts</b>									
Ap	0.00-0.16	1.01	0.23	0.17	0.06	4.37	5.85	17.3	3.95
Bw1	0.16-0.30	0.95	0.20	0.15	0.05	4.72	6.18	20.0	3.23
Bw2	0.30-0.48	1.04	0.22	0.17	0.05	4.84	6.21	21.9	3.52
Bw3	0.48-0.70	0.96	0.22	0.17	0.05	4.41	5.80	18.4	3.17
Bw4	0.70-0.90+	0.92	0.21	0.17	0.04	4.11	5.40	19.2	3.63
<b>6. Maddivalasa soil profile : Clayey, montmorillonitic, iso hyperthermic Chromic Haplustert</b>									
Ap	0.00-0.13	1.14	0.17	0.15	0.02	6.59	7.65	47.8	6.25
Bw	0.13-0.32	1.06	0.21	0.18	0.03	5.03	5.79	38.6	6.68
Bss1	0.32-0.55	1.18	0.20	0.17	0.04	5.82	7.13	31.7	4.44
Bss2	0.55-0.74	0.99	0.25	0.22	0.04	3.89	4.59	25.6	5.58
Bss3	0.74-1.15+	0.98	0.20	0.17	0.03	4.91	5.79	32.3	5.58

The molar concentration of silica ( $\text{SiO}_2$ ) ranged from 0.802 moles to 1.19 moles, highest in *Gujjanganvalasa* profile and lowest in *Gangada* profile. In general a decreasing trend of silica with depth was observed in all the profiles. Molar concentration of sesquioxide ranged from 0.173 moles to 0.275 moles. The highest value was associated with deeper horizon of profile 2 and lowest value was with surface horizon of profile 6. Profiles 2, 3, 4 and 5 showed an increasing trend with depth, however, remaining profiles 1 and 6 did not follow any specific trend in sesquioxide molar concentration with soil depth. Of all the six profiles studied the molar concentration of alumina ranged from 0.149 moles to 0.225 moles with highest value in profile 1 and lowest value in sub surface horizon of profile 6. Particular trend was not observed with soil depth in profiles 1 and 3, while, increasing trend in profiles 2, 4, 5 and profile 6. The molar concentration for iron oxide ranged from 0.023 to 0.080 among various profiles and followed the similar trend of alumina with soil depth. Highest value was recorded in *Gujjanganvalasa* profile, while lowest in *Gangada* profile.

The molar ratio of  $\text{SiO}_2 / \text{R}_2\text{O}_3$  varied from 3.74 to 6.59 in different soil profiles (Table 2). The  $\text{SiO}_2 / \text{Al}_2\text{O}_3$  ratio varied from 4.34 to 7.65 in different soil profiles. The  $\text{SiO}_2 / \text{Fe}_2\text{O}_3$  ratio values varied from 13.7 to 47.8. The molar ratio of  $\text{Al}_2\text{O}_3 / \text{Fe}_2\text{O}_3$  varied from 2.29 to 8.22 among all the soil profiles. In general, wider  $\text{SiO}_2 / \text{R}_2\text{O}_3$ ,  $\text{SiO}_2 / \text{Al}_2\text{O}_3$  revealed that these soils are siliceous in nature due to dominance of silica among chemical fraction. In case of profile 4 and profile 6, the  $\text{SiO}_2 / \text{R}_2\text{O}_3$  and  $\text{SiO}_2 / \text{Al}_2\text{O}_3$  were relatively narrow owing to relatively higher clay content and less sand content while, profiles 1, 2, 3 and profile 5 were associated with wider  $\text{SiO}_2 / \text{R}_2\text{O}_3$  and  $\text{SiO}_2 / \text{Al}_2\text{O}_3$  ratios, which could be ascribed to re-silication, a dominant process operating in these profiles. Wider  $\text{SiO}_2 / \text{R}_2\text{O}_3$  and  $\text{SiO}_2 / \text{Al}_2\text{O}_3$  ratios in some selected soils of Krishna district were also reported by Ramprakash and Seshagiri Rao (2002).

A fairly high  $\text{SiO}_2$  and  $\text{SiO}_2 / \text{Al}_2\text{O}_3$  and  $\text{SiO}_2 / \text{R}_2\text{O}_3$  molar ratio in surface soils indicates more siliceous nature of surface horizons than subsurface horizons and there by advanced stage of pedogenic development (Singh and Mishra, 1994). Relatively less variation in molar ratios of the profiles could be due to variation in chemical composition of parent material. Less variation in molar ratios of red, yellow and black soils of Rajmahal Trap of Bihar was also reported by Tiwary and Mishra (1993). The molar ratios in general, decreased with increase in soil depth because of decreased amount of sand and increased amount of clay which indicates occurrence of intense weathering in the soil that lead to movement of silicate clay, base cations and sesquioxides in to lower layers leaving higher sand fraction in the surface layers. Influence of sand and clay content on molar ratios of some selected soils of Krishna district was reported by Ram Prakash and Seshagiri Rao (2002).

## CONCLUSION

Elemental composition of the soils depends on parent material, climate and intensity of weathering. The present study provided information on total concentration of nutrient elements viz., Ca, Mg, K, Fe, Mn, Cu and Zn. Molar concentration and molar ratios gave information on nature of minerals and stage of weathering.

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## GENETIC VARIABILITY AND CHARACTER ASSOCIATION FOR SEED YIELD AND ITS ATTRIBUTING TRAITS IN MUNGBEAN (*Vigna radiata* (L.) Wilczek)

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### ABSTRACT

The study was carried out on Genetic variability and character association for seed yield and its attributing traits in Mungbean (*Vigna radiata* (L.) Wilczek) for 13 characters of Mungbean on 23 genotypes including check (Samrat) were evaluated during *Kharif*, 2017 in Randomized Block Design. It was recorded that number of pods per plant, number of clusters per plant, seed yield plant<sup>-1</sup> and plant height have high PCV and GCV corresponding heritability coupled with genetic advance. The correlation studies exhibited significant and positive association for all the quantitative characters except with that of pod length, number of seeds per pod and seed index. Biological yield had the maximum direct effect followed by harvest index indicating their direct contribution towards seed yield. The study suggests that number of pods per plant, number of clusters per plant, seed yield per plant and plant height are greatly influenced by the additive gene effect and greater proportion of variations are heritable for these traits.

### INTRODUCTION

Mungbean (*Vigna radiata* (L.) Wilczek) is one of the important pulse crops because of its adaptation to short growth duration, low water requirement, soil fertility and is favoured for consumption due to its easy digestibility and low production of flatus. Average protein content in the seeds is around 24 % which is comparatively rich in lysine. Amino acid analysis indicates that the concentration of sulphur containing Amino acids, namely Methionine and Cystine are low. It is widely cultivated throughout the Asia, including India, Pakistan, Bangladesh, Sri Lanka, Thailand, Laos, Cambodia, Vietnam, Indonesia, Malaysia and South China.

Yield is a complex character and depends on number of component characters, which are quantitatively inherited. As such, before launching any breeding programme, a thorough knowledge of the nature and magnitude of genetic variability and extent of association between yield and other components is very essential. Heritability of a metric character is a parameter of particular significance to the breeder

as it measures the degree of resemblance between the parents and the off-springs and its magnitude indicates the heritability with which a genotype can be identified by its phenotypic expression, while genetic advance aids in exercising the necessary selection pressure.

Character associations provide information about the characters that are correlated in a desirable direction with each other and also with the seed yield. Hence, these correlations partitioned by path analysis into direct and indirect effects will be an added advantage and help in the selection for improvement of yield to a greater extent.

### MATERIAL AND METHODS

The investigation was carried out for 13 characters of Mungbean (*Vigna radiata* (L.) Wilczek) on 23 genotypes *viz.*, KM 1401, KM 1404, KM 1405, KM 1406, KM 1408, KM 1409, KM 1410, KM 1413, KM 1414, KM 1415, KM 1422, KM 1423, KM 2195, KM 2241, T 44, IPM 02-3, IPM 02-14, RMG 268, RMG 1093, RMG 1083, SML 668, MSJ 118, Samrat (Check) in *Kharif*, 2017. Experiment was laid out in

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**Table 1. Mean, GCV, PCV, heritability (broad sense), genetic advance and genetic advance as per cent of mean for seed yield and its components in mungbean**

S. No.	Character	Mean	Coefficient of variation (%)		Broad sense heritability ( $h^2$ ) (%)	Genetic advance	Genetic advance as percent of mean
			Genotypic	Phenotypic			
1.	Days to 50% flowering	43.71	5.96	6.87	75.0	4.66	10.66
2.	Days to maturity	68.50	3.46	4.31	64.0	3.92	5.72
3.	Plant height (cm)	35.74	21.38	22.01	94.4	15.29	42.80
4.	Number of primary branches plant <sup>-1</sup>	3.16	9.98	11.93	69.0	0.54	17.195
5.	Number of clusters plant <sup>-1</sup>	6.82	25.06	26.27	91.0	3.36	49.24
6.	Number of pods plant <sup>-1</sup>	16.49	34.83	35.67	95.0	11.55	70.07
7.	Pod length (cm)	6.95	6.47	8.62	56.0	0.69	10.00
8.	Number of seeds pod <sup>-1</sup>	11.41	5.17	6.84	57.0	0.92	8.05
9.	Biological yield (g)	15.59	16.71	17.84	87.0	5.02	32.23
10.	Harvest index (%)	38.31	14.79	15.51	90.0	11.12	29.04
11.	Seed index (g)	3.51	9.73	10.32	88.0	0.66	18.92
12.	Protein content (%)	22.51	1.57	3.06	26.0	0.37	1.67
13.	Seed yield plant <sup>-1</sup> (g)	5.92	21.67	22.53	92.0	2.54	42.95

Randomized Block Design with a spacing of 30 cm x10 cm and replicated thrice. Recommended agronomical practices *viz.*, thinning, weeding were carried out time to time throughout crop duration. As no additional irrigation was provided the experiment was carried out under rain-fed conditions. A basal dose of 20 kg N and 40 kg of P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> was applied. Five plants were selected at random and biometrical observations such as days to 50 % flowering, days to maturity, plant height (cm), number of primary branches plant<sup>-1</sup>, number of clusters plant<sup>-1</sup>, number of pods plant<sup>-1</sup>, pod length (cm), number of seeds pod<sup>-1</sup>, biological yield (g), harvest index (%), seed index (g), protein content (%) and seed yield plant<sup>-1</sup> (g) were recorded on plot basis. The data was subjected to analysis of variance as specified by Panse and Sukhatme (1985).

**Estimation of PCV and GCV:** The estimation of PCV and GCV was calculated using the formula given by Burton (1952). **Heritability:** The heritability in broad sense  $h^2$  (b) was estimated as per the Allard (1960). **Genetic advance (GA):** The Genetic advance as per cent of mean was estimated as per t Johnson *et al.* (1955).

**Correlation Coefficient:** Phenotypic and genotypic correlation coefficients among different quantitative and qualitative characters were calculated using INDOSTAT software. **Path coefficient analysis:** The direct and indirect effects at phenotypic and genotypic level were estimated by taking seed yield as dependent variable, using path coefficient analysis suggested by Wright (1921) and Dewey and Lu (1959).

Table 2. Phenotypic (above) and Genotypic (below) correlation coefficient of seed yield and its component characters in mungbean

S. No.	Character	$r_p/r_g$	Days to maturity	Plant height (cm)	No. of primary branches plant <sup>-1</sup>	No. of clusters/ plant <sup>-1</sup>	Number of pods plant <sup>-1</sup>	Pod length (cm)	No. of seeds pod <sup>-1</sup>	Biological yield (g)	Harvest index (%)	Seed index (g)	Protein content (%)	Seed yield/plant (g)
1.	Days to 50% Flowering	$r_p$	0.669**	0.317**	0.085	0.348**	0.346**	-0.074	0.096	0.010	0.343**	-0.279**	0.018	0.334**
		$r_g$	0.790**	0.346**	0.099	0.413**	0.414**	-0.043	0.183*	0.025	0.385**	-0.311**	0.065	0.351**
2.	Days to maturity	$r_p$	1.000	-0.081	-0.120	0.169	0.239*	-0.039	-0.092	-0.198*	0.497**	-0.228*	-0.058	0.243*
		$r_g$	1.000	-0.136	-0.153	0.220*	0.301**	-0.114	-0.070	-0.292**	0.638**	-0.339**	-0.032	0.277**
3.	Plant height(cm)	$r_p$		1.000	0.625**	0.220*	0.350**	0.067	0.259**	0.369**	0.016	-0.180*	0.235*	0.302**
		$r_g$		1.000	0.732**	0.211*	0.344**	0.044	0.365**	0.410**	0.005	-0.185*	0.375**	0.306**
4.	Number of primary branches plant <sup>-1</sup>	$r_p$			1.000	0.335**	0.566**	0.0002	0.097	0.323**	0.309**	-0.215*	0.300**	0.501**
		$r_g$			1.000	0.384**	0.646**	-0.051	0.086	0.377**	0.331**	-0.335**	0.545**	0.546**
5.	Number of clusters plant <sup>-1</sup>	$r_p$				1.000	0.803**	-0.355**	-0.017	0.418**	0.307**	-0.407**	-0.066	0.678**
		$r_g$				1.000	0.824**	-0.580**	-0.021	0.445**	0.314**	-0.458**	-0.143	0.691**
6.	Number of pods plant <sup>-1</sup>	$r_p$					1.000	-0.202*	0.101	0.482**	0.489**	-0.461**	0.122	0.853**
		$r_g$					1.000	-0.361**	0.119	0.519**	0.500**	-0.511**	0.230*	0.881**
7.	Pod length (cm)	$r_p$						1.000	0.436**	0.079	-0.027	0.620**	0.002	0.039
		$r_g$						1.000	0.410**	0.126	-0.076	0.898**	0.075	0.020
8.	Number of seeds pod <sup>-1</sup>	$r_p$							1.000	0.249*	-0.170	0.070	0.144	0.074
		$r_g$							1.000	0.378**	-0.183*	0.093	0.021	0.182*
9.	Biological yield (g)	$r_p$								1.000	-0.246*	0.089	0.065	0.643**
		$r_g$								1.000	-0.258**	0.074	0.085	0.663**
10.	Harvest index (%)	$r_p$									1.000	-0.229*	0.101	0.540**
		$r_g$									1.000	-0.260**	0.297**	0.540**
11.	Seed index (g)	$r_p$										1.000	-0.151	-0.131
		$r_g$										1.000	-0.177	-0.170
12.	Protein content (%)	$r_p$											1.000	0.111
		$r_g$											1.000	0.248*

\*Significant at 5% level, \*\* Significant at 1 % level ;  $r_p$  - Phenotypic correlation;  $r_g$  -Genotypic correlation

Table 3. Direct (Diagonal) and indirect effects of yield and its component characters in mungbean at phenotypic level

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of primary branches plant <sup>-1</sup>	Number of clusters plant <sup>-1</sup>	Number of pods plant <sup>-1</sup>	Pod length (cm)	Number of seeds pod <sup>-1</sup>	Biological yield (g)	Harvest index (%)	Seed index (g)	Protein content (%)	Seed yield plant <sup>-1</sup> (g)
Days to 50% flowering	<b>0.095</b>	0.064	0.030	0.008	0.033	0.033	-0.007	0.009	0.001	0.032	-0.026	0.001	0.334
Days to maturity	-0.021	<b>-0.032</b>	0.002	0.003	-0.005	-0.007	0.001	0.003	0.006	-0.016	0.007	0.001	0.243
Plant height (cm)	-0.022	0.005	<b>-0.069</b>	-0.043	-0.015	-0.024	-0.004	-0.018	-0.025	-0.001	0.012	-0.01	0.302
Number of primary branches plant <sup>-1</sup>	-0.0006	0.000	-0.004	<b>-0.006</b>	-0.002	-0.003	0.000	-0.0006	-0.002	-0.002	0.001	-0.002	0.501
Number of clusters plant <sup>-1</sup>	0.021	0.010	0.013	0.021	<b>0.062</b>	0.050	-0.022	-0.001	0.026	0.019	-0.025	-0.004	0.678
Number of pods plant <sup>-1</sup>	0.100	0.169	0.101	0.164	0.233	<b>0.290</b>	-0.058	0.029	0.140	0.142	-0.133	0.035	0.853
Pod length (cm)	-0.007	-0.003	0.006	0.000	-0.034	-0.019	<b>0.095</b>	0.041	0.007	-0.002	0.059	0.0003	0.039
Number of seeds pod <sup>-1</sup>	-0.006	0.005	-0.016	-0.006	0.001	-0.006	-0.027	<b>-0.062</b>	0.015	0.010	-0.004	-0.009	0.074
Biological yield (g)	0.006	-0.125	0.232	0.203	0.263	0.303	0.049	0.157	<b>0.629</b>	-0.155	0.056	0.041	0.643
Harvest index (%)	0.178	0.259	0.008	0.161	0.160	0.255	-0.014	-0.089	-0.128	<b>0.521</b>	-0.119	0.053	0.540
Seed index (g)	-0.012	-0.010	-0.007	-0.009	-0.017	-0.020	0.027	0.003	0.003	-0.010	<b>0.043</b>	-0.006	-0.131
Protein content (%)	0.000	-0.000	0.003	0.004	-0.001	0.001	0.000	0.002	0.001	0.001	-0.002	<b>0.015</b>	0.111

Residual effect = **0.1671**

## RESULTS AND DISCUSSION

Analysis of variance indicated the existence of significant genotypic differences among the genotypes for the yield and its component characters. The estimates of genotypic and phenotypic coefficients of variation, heritability, genetic advance, genetic advance as percent of mean and grand mean for 13 traits are presented in Table 1.

A perusal of genetic parameters revealed high phenotypic and genotypic coefficients of variation for number of pods per plant (35.67, 34.83), number of clusters plant<sup>-1</sup> (26.27, 25.06), seed yield plant<sup>-1</sup> (22.53, 21.67) and plant height (22.01, 21.38). The results on heritability (broad sense) that majority of the character *viz.*, number of pods plant<sup>-1</sup> (95 %), plant height (94.4%), seed yield plant<sup>-1</sup> (92 %), number of clusters plant<sup>-1</sup> (91%), harvest index (90 %), seed index (88 %), biological yield (87 %), days to 50 % flowering (75%), number of primary branches plant<sup>-1</sup> (69 %) and days to maturity (64 %) exhibited high heritability estimates. Genetic advance was found to be high for plant height (15.29), number of pods plant<sup>-1</sup> (11.55) and harvest index (11.12). The estimates of heritability coupled with high genetic advance as percent of mean was observed number of pods plant<sup>-1</sup> (70.07), number of clusters plant<sup>-1</sup> (49.24), seed yield plant<sup>-1</sup> (42.95), plant height (42.80), biological yield (32.23), harvest index (29.04). Similar kind of results were observed Kamleshwar *et al.* (2013), Payasi (2015), Hemavathy *et al.* (2015), Shiv *et al.* (2017).

Higher estimates of PCV (measured for all the morphological characters) than that of corresponding GCV validates the positive influence of environmental factors in expression of different morphological traits under different environments. It was recorded that number of pods plant<sup>-1</sup>, number of clusters plant<sup>-1</sup>, seed yield plant<sup>-1</sup> and plant height had higher PCV and GCV corresponding heritability coupled with genetic advance indicating better chances for selection.

Correlation coefficient analysis (Table 2) seed yield plant<sup>-1</sup> shows highly positive significant association with all the morphological characters studied was number of pods plant<sup>-1</sup> (0.853\*\*, 0.881\*\*), number of clusters plant<sup>-1</sup> (0.678\*\*, 0.691\*\*), biological yield (0.643\*\*, 0.663\*\*) at phenotypic and genotypic correlation. The findings are in conformity with studies of Kamleshwar *et al.* (2013) who reported that number of secondary branches plant<sup>-1</sup>, number of bunches plant<sup>-1</sup>, number of pods plant<sup>-1</sup>, number of grains pod<sup>-1</sup>, pod length and 100-seed weight had shown positive and significant correlation.

Path coefficient analysis (Table 3 & Table 4) revealed that characters *viz.*, biological yield (0.629), harvest index (0.521), number of pods plant<sup>-1</sup> (0.290), days to 50 % flowering (0.095), pod length (0.095), number of clusters plant<sup>-1</sup> (0.062), seed index (0.043), protein content (0.015) exhibited positive direct effect on seed yield at phenotypic level and genotypic level biological yield (0.770), harvest index (0.677), number of pods plant<sup>-1</sup> (0.245), days to 50 % flowering (0.162), seed index (0.089), number of primary branches plant<sup>-1</sup> (0.035), number of seeds pod<sup>-1</sup> (0.021). The findings are in conformity with reports of Hemavathy *et al.* (2015) who reported that maximum direct effect on seed yield was observed through number of pods plant<sup>-1</sup>, number of pods per cluster, number of clusters plant<sup>-1</sup> and 100-seed weight.

The association of different component characters among themselves and with yield is quite important for devising an efficient selection criterion for yield. The total correlation between yield and component characters may be some times misleading, as it might be an over-estimate or under-estimate because of its association with other characters. Hence, indirect selection by correlated response may not be fruitful. When many characters are affecting a given character, splitting the total correlation into direct and indirect effects of cause as devised by Wright (1921), would give more

Table 4. Direct (diagonal) and indirect effects of yield and its component characters in mungbean at genotypic level

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of primary branches plant <sup>-1</sup>	Number of clusters plant <sup>-1</sup>	Number of pods plant <sup>-1</sup>	Pod length (cm)	Number of seeds pod <sup>-1</sup>	Biological yield (g)	Harvest index (%)	Seed index (g)	Protein content (%)	Seed yield plant <sup>-1</sup> (g)
Days to 50% flowering	<b>0.162</b>	0.128	0.056	0.016	0.067	0.067	-0.007	0.002	0.004	0.062	0.050	0.010	0.351
Days to maturity	-0.079	<b>-0.100</b>	0.013	0.015	-0.022	-0.030	0.011	0.007	0.029	-0.064	0.034	0.003	0.277
Plant height (cm)	-0.048	0.019	<b>-0.139</b>	-0.102	-0.029	-0.048	-0.006	-0.051	-0.057	-0.0008	0.025	-0.052	0.306
Number of primary branches plant <sup>-1</sup>	0.003	-0.005	0.026	<b>0.035</b>	0.013	0.022	-0.001	0.003	0.013	0.011	-0.011	0.019	0.546
Number of clusters plant <sup>-1</sup>	-0.045	-0.024	-0.023	-0.041	<b>-0.109</b>	-0.089	0.063	0.002	-0.048	-0.034	0.050	0.015	0.691
Number of pods plant <sup>-1</sup>	0.101	0.073	0.084	0.158	0.202	<b>0.245</b>	-0.088	0.029	0.127	0.122	-0.125	0.056	0.881
Pod length (cm)	0.003	0.009	-0.003	0.004	0.047	0.029	<b>-0.081</b>	-0.034	-0.010	0.006	-0.073	-0.006	0.020
Number of seeds pod <sup>-1</sup>	0.003	-0.001	0.007	0.001	-0.0005	0.002	0.008	<b>0.021</b>	0.008	-0.003	0.002	0.0004	0.182
Biological yield (g)	0.019	-0.225	0.316	0.291	0.343	0.400	0.097	0.291	<b>0.770</b>	-0.199	0.057	0.066	0.663
Harvest index (%)	0.261	0.432	0.003	0.224	0.213	0.339	-0.051	-0.124	-0.175	<b>0.677</b>	-0.176	0.201	0.540
Seed index (g)	-0.027	-0.030	-0.016	-0.030	-0.041	-0.045	0.080	0.008	0.006	-0.023	<b>0.089</b>	-0.015	-0.170
Protein content (%)	-0.003	0.001	-0.018	-0.027	0.007	-0.011	-0.003	-0.001	-0.004	-0.014	0.008	<b>-0.050</b>	0.248

Residual effect = **0.0370**

meaningful interpretation to the cause of association between the dependent variable like yield and independent variables such as yield components. This kind of information will be helpful in formulating the selection criteria. The selection for these characters is likely to bring about an overall improvement in single plant yield directly.

## CONCLUSION

Wide range of variation was noticed among 23 genotypes of Mungbean. It was recorded that the characters viz., number of pods plant<sup>-1</sup>, number of clusters plant<sup>-1</sup>, seed yield plant<sup>-1</sup> and plant height had high PCV and GCV corresponding heritability coupled with genetic advance. Character association studies revealed positive significant association with days to 50 % flowering, days to maturity, plant height, number of primary branches plant<sup>-1</sup>, number of clusters plant<sup>-1</sup>, number of pods plant<sup>-1</sup>, pod length, number of seeds pod<sup>-1</sup>, seed yield both phenotypic and genotypic levels. Path co-efficient analysis indicated that the characters viz., days to 50 % flowering, number of pods plant<sup>-1</sup>, biological yield, harvest index and seed index had positive direct effect on seed yield at phenotypic and genotypic levels. The genotypes KM 2195, RMG 268, KM 1423, KM 1401, RMG 1093, RMG 1083 were found promising among the studied genotypes as these performed well for most of the important quantitative traits.

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# INFLUENCE OF WEATHER FACTORS ON DISEASE SEVERITY AND DEVELOPMENT OF RICE BLAST CAUSED BY *PYRICULARIA GRISEA* SACC

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## ABSTRACT

The influence of weather factors was studied under natural field conditions for disease severity and development of rice blast caused by *Pyricularia grisea*. During *Kharif*, 2010 and *Kharif*, 2011 (pooled), the Percent Disease Index (PDI) showed significant positive correlation with minimum temperature and evening relative humidity. The pooled analysis of two seasons provided the prediction model for *Kharif* as  $Y = 107.67327 - 4.10070_{\text{min. temp}} + 0.26864_{\text{morn. RH}} + 0.14116_{\text{even. RH}}$ . During *Rabi*, 2010 and *Rabi*, 2011 (pooled) the correlation studies revealed that the PDI showed significant negative correlation with maximum and minimum temperature and significantly positive correlation with evening relative humidity. Based on the pooled analysis of two seasons, the prediction model for *Kharif* was arrived as  $Y = 94.41900 - 4.57171_{\text{Min. Temp}} + 0.85643_{\text{Even. RH}} - 3.06645_{\text{Rainy days}}$ . The prediction models help to frame the management practices for controlling the rice blast in an effective manner.

## INTRODUCTION

Rice (*Oryza sativa* L.) is an important food crop in supplying approximately 23% per capita energy for six billion people worldwide. Rice blast caused by *Pyricularia grisea* Sacc. is an important biotic constraint for rice production across the world, wherein, rice is being cultivated. (Ratna Madhavi *et al.*, 2011). Under favourable conditions losses due to blast may range up to 90% depending upon the part of plant infected (Ahmad *et al.*, 2011). In Andhra Pradesh, blast on rice appeared during 1995-1997 and severity ranged from 14% to 27% and the yield loss was about 27%-35% (Rajarajeswari and Muralidharan, 2006). Hence, the investigation was taken up with the objective of studying the influence of weather factors on severity and development of rice blast.

## MATERIAL AND METHODS

To study the influence of weather factors on disease severity, the epidemiological work was taken up under natural conditions at Darsi for two seasons, *i.e.*, *Kharif*, 2010 and *Kharif*, 2011 and *Rabi*, 2010 and *Rabi*, 2011. Weather data for each growing

season were collected from the meteorological observatory located at Agricultural Research Station, Darsi. The susceptible variety 'BPT 5204' was selected for the study. Fifty plants were selected randomly in "W" pattern and tagged. The data was recorded at weekly intervals on Percent Disease Index (PDI) by using 0-9 scale (IRRI, 2002). The correlation and multiple regression analysis was computed as per the standard methods to work out relationship between weather factors and disease development. The weather factors considered for correlation studies were:

- $X_1$  : Maximum temperature ( $^{\circ}\text{C}$ )
- $X_2$  : Minimum temperature ( $^{\circ}\text{C}$ )
- $X_3$  : Morning relative humidity (%) 8.00 AM to 9.00 AM
- $X_4$  : Evening relative humidity (%) 5.00 PM to 6.00 PM
- $X_5$  : Rain fall (mm)
- $X_6$  : Rainy days

The correlation coefficient was calculated by

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$$r = \frac{\sum X Y}{\sqrt{(\sum X^1)(\sum X^2)}}$$

Multiple linear regression was calculated as

$$Y = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_K X_K$$

Using step down regression analysis, prediction model was worked out for rice blast

**RESULTS AND DISCUSSION**

The influence of weather factors on PDI of rice blast was studied during *Kharif*, 2010 and *Kharif*, 2011. The PDI of rice blast was recorded at weekly intervals from 24.06.2010 to 25.11.2010 during *Kharif*, 2010 and from 17.06.2011 to 10.11.2011 during *Kharif*, 2011. During *Rabi*, 2010. PDI of rice blast was recorded from 18.11.2010 to 15.04.2011 and for *Rabi*, 2011 the PDI of rice blast was recorded from 25.11.2011 to 12.04.2012.

The data on weather parameters such as maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, rain fall and rainy days was recorded at weekly intervals during the entire period of experimentation. Correlation and multiple linear regression analysis were carried out using the values of Per cent Disease Index (PDI) as dependent variable and weather parameters as independent variables.

**Relationship of weather factors with severity of rice blast disease during *Kharif*, 2010 and *Kharif*, 2011 (pooled)**

The variation in weather parameters and PDI during *Kharif* 2010 and 2011 (pooled) is presented in Table 1. The correlation studies revealed that the PDI showed non-significant negative correlation with maximum temperature and rainy days and significant positive correlation with minimum temperature and evening relative humidity. The remaining factors showed non-significant correlation with PDI.

The multiple linear regression analysis indicated that all the weather parameters collectively influenced disease severity to an extent of 77.35 per cent during *Kharif*, 2010 and *Kharif*, 2011. The regression equation is fitted as below (Table 2):

$$Y = 150.38057 - 0.82650_{\text{Max. Temp}} - 4.37377_{\text{Min. Temp}} + 0.15857_{\text{Morn. RH}} + 0.14072_{\text{Even. RH}} + 0.41647_{\text{Rain fall}} - 1.47606_{\text{Rainy days}}$$

Step down regression analysis revealed that the minimum temperature, morning R.H and evening relative humidity accounted for 70.07 per cent of variation (R<sup>2</sup>=0.70) in PDI. The following prediction equation was worked out to predict PDI using minimum temperature, morning relative humidity and evening relative humidity.

$$Y = 107.67327 - 4.16870_{\text{Min. Temp}} + 0.26864_{\text{Morn. RH}} + 0.14116_{\text{Even. RH}}$$

**Relationship of weather factors with rice blast PDI during *Rabi* 2010 and *Rabi*, 2011 (pooled)**

The variation in weather parameters and PDI during *Rabi*, 2010 and *Rabi*, 2011 (pooled) is presented in Table 3. The correlation studies revealed that the PDI showed significant negative correlation with maximum and minimum temperature and significant positive correlation with evening relative humidity. The morning relative humidity showed non-significant correlation. Rain fall and rainy days showed non-significant negative correlation with PDI.

The variation in weather parameters and PDI during *Rabi* 2010 and 2011 (pooled) is presented in Table 3. The correlation studies revealed that the PDI showed significant negative correlation with maximum and minimum temperature and significantly positive correlation with evening relative humidity. The morning relative humidity showed non-significant correlation. Rain fall and rainy days showed non-significant negative correlation with PDI.

The multiple linear regression analysis indicated that all the weather parameters collectively

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influenced the rice blast severity to an extent of 59.58 per cent during *Rabi*, 2010 and *Rabi*, 2011 (pooled). The regression equation is fitted as below:

$$Y = 143.72402 - 1.23135_{\text{Min. Temp}} - 3.97650_{\text{Min. Temp}} - 0.14582_{\text{Morn. RH}} + 0.64792_{\text{Even. RH}} + 0.35672_{\text{Rain fall}} - 3.47931_{\text{Rainy days}}$$

Step down regression analysis revealed that the minimum temperature and evening relative humidity accounted for 51.63 per cent of variation ( $R^2=0.52$ ) in PDI (Table 4). These parameters in combination with rainy days accounted for 56.77 per cent variation ( $R^2=0.57$ ) in severity. The following prediction equation was worked out to predict PDI using minimum temperature, evening relative humidity and rainy days as independent variables.

$$Y = 94.41900 - 4.57171_{\text{Min. Temp}} + 0.85643_{\text{Even. RH}} - 3.06645_{\text{Rainy days}}$$

During *Kharif*, 2010 and *Kharif*, 2011 (pooled), the PDI showed significant positive correlation with minimum temperature and evening relative humidity. Step down regression analysis revealed that the minimum temperature, morning and evening relative humidity accounted for 70.07 per cent of variation ( $R^2=0.70$ ) in PDI. Based on pooled analysis of two seasons, the prediction model for *Kharif* was arrived as  $Y = 107.67327 - 4.10070_{\text{min. temp}} + 0.26864_{\text{morn. RH}} + 0.14116_{\text{even. RH}}$

**Table 1. Simple correlation between blast PDI and weather parameters during *Kharif*, 2010 and *Kharif*, 2011 (pooled)**

S. No	Weather Parameters	Correlation coefficient (r)
1.	X <sub>1</sub> – Maximum Temperature	-0.10656
2.	X <sub>2</sub> – Minimum Temperature	-0.79931**
3.	X <sub>3</sub> – Morning RH	0.64453**
4.	X <sub>4</sub> – Evening RH	0.46205*
5.	X <sub>5</sub> – Rain fall	-0.18643
6.	X <sub>6</sub> – Rainy days	-0.21343

**Correlation matrix**

Character	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	Y
X <sub>1</sub>	1.00000						
X <sub>2</sub>	0.09544	1.00000					
X <sub>3</sub>	-0.26067	-0.59484	1.00000				
X <sub>4</sub>	-0.11699	-0.36065	0.42486	1.00000			
X <sub>5</sub>	-0.16738	-0.04056	0.32916	0.26446	1.00000		
X <sub>6</sub>	-0.52276	-0.10442	0.07791	0.12383	0.46740	1.00000	
Y	-0.10656	0.79931	0.64453	0.46205	-0.18643	-0.21343	1.0000

Significance Levels 0.05 0.01  
 If correlation r => 0.43271 0.56143

\*\* Highly significant;  
 \* Significant

**Table 2. Multiple Regression Analysis of influence of weather parameters on blast severity for Kharif, 2010 and Kharif, 2011 (pooled)**

Weather Parameters	Regression Co-efficient ( $\beta$ Value)	Standard error	t calculated value	t probability	Intercept	R <sup>2</sup>
X <sub>1</sub> (Max. Temp)	-0.82650	1.3481	0.613	0.864		
X <sub>2</sub> (Min. Temp)	-4.37377	1.3535	3.231	0.030		
X <sub>3</sub> (Morn. Rh)	0.15857	0.2803	0.566	0.749	150.38057	0.7263
X <sub>4</sub> (Even. Rh)	0.14072	0.1626	0.866	0.216		
X <sub>5</sub> (Rain fall)	0.41647	0.9253	0.455	0.515		
X <sub>6</sub> (Rainy days)	-1.47606	2.1319	0.692	0.140		

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6$$

$$= 150.38057 - 0.82650 X_1 - 4.37377 X_2 + 0.15857 X_3 + 0.14072 X_4 + 0.41647 X_5 - 1.47606 X_6$$

During *Rabi*, 2010, PDI showed significant negative correlation with morning and evening relative humidity. Step down regression analysis revealed that the evening relative humidity accounted for 67.30 per cent of variation ( $R^2=0.67$ ) in PDI. This parameter in combination with morning relative humidity accounted for 68.72 per cent variation ( $R^2= 0.69$ ) in leaf blast severity. During *Rabi*, 2011, the PDI showed significant positive correlation with minimum temperature and evening relative humidity. During *Rabi* 2010 and 2011 (pooled) the correlation studies revealed that the PDI had significant negative correlation with maximum and minimum temperature and significantly positive correlation with evening relative humidity. The morning relative humidity showed non-significant correlation. Rain fall and rainy days showed non significant negative correlation with PDI.

Step down regression analysis revealed that the minimum temperature and evening relative humidity accounted for 51.63 per cent of variation ( $R^2=0.52$ ) in PDI. These parameters in combination with rainy days accounted for 56.77 per cent variation ( $R^2= 0.57$ ) in severity. The following prediction equation was worked out to predict PDI using minimum temperature, evening relative humidity and rainy days as independent variables. Khan and Libby (1958) reported that the infection of *P. grisea* occurred at 15°C -35°C with 16-20 h dew exposure. The optimum temperature for lesion development was 27°C -29°C and the minimum temperature reported for symptom development was 14°C-15°C and the optimum temperature for disease development and sporulation was 22°C -26°C. Padmanabhan (1965) recorded that the blast disease occurred whenever

**Table 3. Simple correlation between blast PDI and weather parameters during Rabi 2010 & 2011 (pooled)**

S. No	Weather Parameters	Correlation coefficient (r)
1.	X <sub>1</sub> – Maximum Temperature	-0.66672
2.	X <sub>2</sub> – Minimum Temperature	- 0.62569**
3.	X <sub>3</sub> – Morning RH	0.45428
4.	X <sub>4</sub> – Evening RH	0.59200**
5.	X <sub>5</sub> – Rain fall	-0.27311
6.	X <sub>6</sub> – Rainy days	-0.04234

**Correlation matrix**

Character	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	Y
X <sub>1</sub>	1.00000						
X <sub>2</sub>	0.59720	1.00000					
X <sub>3</sub>	-0.60885	-0.59437	1.00000				
X <sub>4</sub>	-0.77525	-0.43863	0.60292	1.00000			
X <sub>5</sub>	-0.51451	-0.30303	0.48742	0.31488	1.00000		
X <sub>6</sub>	-0.28004	-0.23255	0.47362	0.37279	0.53869	1.00000	
Y	-0.66672	- 0.62569	0.45428	0.59200	0.27311	0.04234	1.00000

Significance Levels

0.05

0.01

If correlation r =>

0.43283

0.54871 ; \*\* Highly significant; \* Significant

there was a coincidence of low minimum temperature of 26°C or below along with relative humidity of 90% or more during any of the susceptible growth stage, viz., seedling, post transplanting, tillering and neck emergence stages and also stated that the infection was higher when minimum temperature was 20°C - 22°C. Asai *et al.* (1967) reported that blast epidemics occur mainly due to disease proneness of the host, the amount of inoculum, temperature and length of dew period on plant surface. Low night temperature is one of the most important critical factors which predispose rice plants to blast infection (Subramanian, 1967). Choong *et al.* (1988) reported that the temperatures between 23°C-26°C and relative

humidity about 90% are considered to be highly favourable for blast development and also stated that the most favourable conditions for rice blast development are mean temperature between 23°C and 26°C, 24 h of leaf wetness and 24 h of high relative humidity (90%).

Gohel and Chauhan (2009) reported that rice blast was influenced by weather factors and varied from place to place. It appeared during first week of September (3.70%) to 29<sup>th</sup> September (considered as window period ) and the minimum temperature, more number of rainy days and relative humidity were the most important factors favouring blast

**Table 4. Multiple Regression Analysis of influence of weather parameters on blast severity during Rabi 2010 and 2011 (pooled)**

Weather Parameters	Regression Co-efficient ( $\beta$ Value)	Standard error	t calculated value	t probability	Intercept	R <sup>2</sup>
X <sub>1</sub> (Max. Temp)	-1.23135	2.2537	0.546	0.593		
X <sub>2</sub> (Min. Temp)	-3.97650	2.2483	1.769	0.099		
X <sub>3</sub> (Morn. Rh)	-0.14582	0.8438	0.173	0.865		
X <sub>4</sub> (Even. Rh)	0.64792	0.5544	1.169	0.262	143.72402	0.5958
X <sub>5</sub> (Rain fall)	0.35672	0.8053	0.443	0.665		
X <sub>6</sub> (Even. Rh)	-3.47931	2.8087	1.239	0.236		

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6$$

$$= 143.72402 - 1.23135 X_1 - 3.97650 X_2 - 0.14582 X_3 + 0.64792 X_4 + 0.35672 X_5 - 3.47931 X_6$$

development which is in conformity with this study findings.

## CONCLUSION

The correlation and regression studies can be considered as prototype model rendering a baseline for future improvement in leaf blast disease forecasting. It was analyzed that regression equations can be used as empirical model to predict rice blast disease caused by *Pyricularia grisea*. Thus, the prediction equations of both the years of the investigation can be used for forecasting leaf blast disease severity in the zone and can be utilized as a component of integrated disease management programme by minimizing chemical spray for the control of the disease. However, its practical utility in other areas needs further investigation. For more accurate prediction, other meteorological and

biological variables of host and pathogen need to be considered.

Out of six independent weather variables considered for prediction of disease severity, morning relative humidity, rainfall and maximum temperature were identified as critical weather parameters following multiple regression analysis. The five selected independent variables were either positively, negatively or partially correlated with disease severity. The evening relative humidity and minimum temperature exhibited significant positive effect on percent disease severity.

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## STUDY OF MORPHOLOGY, CHARACTERS, GENESIS AND CLASSIFICATION OF SOILS OF AGRICULTURAL COLLEGE FARM, NAIRA

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### ABSTRACT

Four representative soil pedons from red, black and associated soils were identified as major soils types in the 250 acres Naira College farm. The horizon wise soil samples were collected from each pedon and subjected for laboratory analysis for characterising soils. The study area is under semi-arid climate with distinct wet and dry seasons. The soil moisture regime and temperature regimes were ustic and iso-hyperthermic temperature, respectively. The parent material was Granite-gneiss to calcareous murrum combined granite-gneiss. The soils were moderately deep to very deep in depth. Argillic subsurface diagnostic horizon was found in upland red soils while cambic subsurface diagnostic horizon was found in associate red and black soils on middle lands. In low land soils, deep and wide cracks in surface and intersecting slickensides in subsurface were observed. Soil churning by the process of argillo-pedoturbation also observed in low land deep black soils. The texture of the soils ranged from sandy loam to sandy clay loam in upland, sandy clay loam to sandy clay in associated black soils and sandy clay to clay texture in low land black soils. The coefficient of linear extensibility (COLE) was 0.020 to 0.04 in medium black soils and was 0.09 to 0.19 in deep black soils of low lands. The soils were slightly acidic to moderately alkaline, non saline and low to medium in organic carbon content. The CEC values ranged from 11.0 cmol (p+) kg<sup>-1</sup> to 34.3 cmol (p+) kg<sup>-1</sup> and base saturation percent was 44.8 to 86.14. The soil exchange complex was dominated by Ca<sup>++</sup> followed by Mg<sup>++</sup>, Na<sup>+</sup> and K<sup>+</sup>. Further, the topography was varying from moderately sloping uplands to nearly levelled low lands. The soils were classified as Typic Haplustalfs, Typic Haplustepts, vertic Haplustepts and Typic Haplusterts.

### INTRODUCTION

Optimum utilization of available land resources on a sustainable basis require timely reliable information on soils regarding their nature, extent and spatial distribution along with their grouping (Devi and Kumar, 2008).

The terrain of Agricultural College Farm, Naira, Srikakulam district, Andhra Pradesh was moderately sloping towards north, hence, it is probable that the land was subjected to different degrees of erosion resulting in deep and finer soils in lower topographic positions and coarser soils with limited depths at higher topographic positions. The major soil types of the farm were red, black and associated soils. Further, the land use was also differed *i.e.* rainfed crops and orchards in the higher elevations and irrigated rice followed by pulses in middle and lower slopes. This variability of slope and land use resulted in variable soil depth and soil

characters. The college farm had an area of 250 acres, comprising red sandy loams on rainfed uplands, reddish yellow soils on irrigated middle lands, medium black soils on irrigated middle lands and deep black soils on irrigated low lands. Necessary information on soil about characterisation, taxonomy and genesis of these soils was not available about Agricultural College Farm, Naira, hence, this investigation was taken up to put the soils for optimum use.

### MATERIAL AND METHODS

Agricultural College Farm, Naira was located in between 83°56.095 to 83°56.993 E latitude and 18°23.045 to 18°26.988N longitude. The physiography was moderately sloping rainfed uplands to nearly level irrigated low lands. General soil types (250 acres) were red, black and associated soils. The detailed soil survey was conducted during April, 2016 to May, 2016 using village map of 1: 5,000

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scale as per the procedure outlined by AIS & LUS (1971). The location map of study area and representative pedons was presented in Fig. 1. The climate of the area is semi-arid with alternate wet and dry seasons based on past one decade meteorological data from 2008 to 2017. The mean annual temperature and rain fall were 26.48°C, 982.7 mm, respectively. Auger bores, mini pits, erosion cuts of eight pedons were studied. Soil correlation exercise resulted in four typical pedons representing entire 250 acres area *i.e.* one in rainfed uplands and two in irrigated mid lands and one in irrigated low lands. Morphological properties were described in the field (Soil Survey Division Staff, 2005) and horizon wise soil samples were collected from each pedon and subjected for laboratory analysis for physical and physico- chemical characters by employing standard procedures. Soil particle size distribution was assessed by the procedure as described by Piper (1966). Soil reaction (pH) and soluble salt concentration (EC) were estimated by adopting procedure outlined by Jackson (1973). Organic carbon content of the soil samples was estimated by Walkley and Black (1934) wet digestion method. Exchangeable bases and cation exchange capacity (CEC) were determined by centrifuge extraction procedure using neutral normal ammonium acetate as described by Bower *et al.* (1952). The soils were classified taxonomically as per the procedure given by Soil Survey Staff (2014).

## RESULTS AND DISCUSSION

**Soil morphology:** The depth of the soils varied from 0.80 m to 1.48 m (Table 1). The soils were moderately deep in red sandy loams of uplands, deep in associate soils of middle lands and very deep in black soils of low lands. In case of pedons 2, 3 and 4 calcarious murrum was found in deeper horizons. Surface horizons in all the pedons were designated as Ap due to the disturbance by cultivation (Table 1). The colour of the upland pedon varied from yellowish brown to reddish brown with a hue varied from 2.5

YR to 7.5 YR, colour value ranged from 3 to 5 and chroma ranged between 3 and 6. Midland soils exhibited brown to dark yellowish brown with a hue of 5 YR to 10YR, value and chroma ranged from 4 to 5 and 2 to 4, respectively. Low land pedon was grayish brown to dark grayish brown in colour with hue of 5 YR to 10YR, value ranged from 4 to 5 and chroma from 1 to 2. The dark colour in black soils of middle and low land soil pedons is due to adsorption of dispersed organic matter on the surface of clay particles, forming clay- humus complexes. Red sandy loam soils of uplands (Pedon 1) exhibited Ap, Bt<sub>1</sub>, Bt<sub>2</sub>, Bt<sub>3</sub>, C<sub>1</sub> horizon sequence, which is a result of eluviation and illuviation of clay in the soil pedon. Thangasamy *et al.* (2005) also reported illuvial accumulated clay in subsurface horizons of red soils of Sivagiri watershed of Chittoor district in Andhra Pradesh.

Pedons 2 and 3 exhibited cambic (Bw) sub-surface horizons which were due to alteration of material from its original condition, as depicted by structural development. Low lands (pedon 4) showed Ap, Ass1, Ass2, Ass3 and Ass4 horizon sequence. Similar horization of AC pedon in certain black soils of Karnataka was earlier observed by Rudramurthy and Dasog (2001). Upland and midland soil pedons showed clay illuviation to subsurface horizons made the boundary clear, however, low land pedon showed diffuse wavy boundary due to pedo-turbation process. Balapande *et al.* (2007) also reported diffuse boundary at horizons of black clay soils of Maharashtra. The pedons 1, 2 and 3 exhibited variable texture with depth ranging from sandy loam to sandy clay while pedon 4 exhibited uniform texture throughout the pedon. These textural variations were caused by topographic variation, in-situ weathering, and translocation of clay and age of soils (Sireesha and Naidu, 2013).

The pedons 1 and 2 showed granular structure at surface and sub-angular blocky to angular blocky in lower layers. Pedons 3 and 4 exhibited

sub-angular blocky to angular blocky structure. The variation in structural development could be due to movement of clay and soluble material to lower layers as well as over burden pressure of surface layer on sub- surface layers (Marathe *et al.*, 2003). Variable consistency was observed among horizons of pedons 1, 2 and 3 which could be due to variable texture and nature of clay mineral (Thangasamy *et al.*, 2005). Pedon 4 exhibited hard to very hard, very sticky and very plastic consistence, due to finer texture and expanding type of clay which was evidenced by presence of deep wide surface cracks and presence of intersecting slickensides in the lower horizons (Ashokkumar and Prasad, 2010).

#### **Physical and physic-chemical properties:**

The clay content of the pedons ranged from 17.2% to 42.5 per cent (Table 2). In general increasing trend of clay with soil depth was observed. Gradual increase in clay content with depth might be due to vertical migration or translocation of clay from surface to sub-surface horizons with percolating water in relatively coarse textured soils (pedon 1 and pedon 2) and intense chemical weathering in subsurface layers of fine textured soils (pedon 3 and pedon 4). Reddy and Naidu (2016) also reported such variabilities in soil texture in soils of Chennur mandal in Kadapa district. The sand content of various horizons of the pedons varied from 40.70 % to 66.2%. In case of pedon 3, coefficient of linear extensibility (COLE) ranged from 0.02- 0.03, while in pedon 4 it was 0.06-0.13.

The pH of the soils ranged from 6.03 to 8.35. Pedon 1 exhibited slightly acidic to slightly alkaline pH, pedon 2 and pedon 3 exhibited neutral to moderately alkaline and pedon 4 was slightly alkaline to moderately alkaline in reaction. All the pedons showed an increasing trend in soil pH with depth, which could be due to continuous removal of basic cations by crop plants from surface layers and or leaching of basic cations from surface to deeper layers along with percolating water as well as release

of organic acids in surface layers during decomposition of organic matter (Meena *et al.*, 2014). Deeper layers of pedons 2, 3 and 4 showed free calcium carbonate. The soluble salt concentration of the soils ranged from 0.13 dS m<sup>-1</sup> to 1.35 dS m<sup>-1</sup>. All the pedons studied were non-saline in nature and showed an increasing depth function due to leaching of salts during monsoon season (Satyavathi and Reddy, 2004). The lower electrical conductivity in pedon 1 and pedon 2 could be due to relatively coarse texture, which encouraged leaching of soluble salts, while in pedon 3 and pedon 4 finer texture caused poor drainage and subsequent accumulating of salts (Jayaramarao, 2012).

The organic carbon content in different horizons of all the four pedons ranged from 0.12 % to 0.75%. The organic carbon status of the soils in general was medium in surface layers and very low in sub surface layers. Warm climatic conditions of the study area caused rapid decomposition of organic matter resulting in low to medium organic carbon content (Niranjana *et al.*, 2011). The organic carbon content showed a decreasing trend with soil depth, which could be due to enriching of surface layer with crop residue, addition of FYM to the surface soil due to cropping (Vijayakumar *et al.*, 2011). Notable CaCO<sub>3</sub> content was recorded in lower horizons of pedon 2, pedon 3 and pedon 4, which ranged from 1.2% to 5.3%. The presence of CaCO<sub>3</sub> in deeper soil layers was attributed to the leaching of bicarbonate from upper layer during rainy season and their subsequent precipitation as carbonate in the lower layer (Leelavathi *et al.*, 2009).

The cation exchange capacity of the soil horizons varied from 11.0 cmol (p<sup>+</sup>) kg<sup>-1</sup> to 34.3 cmol (p<sup>+</sup>) kg<sup>-1</sup> soil. All the four pedons exhibited an increasing trend of CEC with depth. The data revealed that although there was not much variation in CEC among the horizons of each pedons, wider variations were exhibited among the pedons, which might be due to variation in nature and amount of clay. Pedon

4 recorded higher CEC which may be due to high clay content and expanding nature of clay, as evidenced by wide and deep surface cracks observed during summer and high CEC/ clay ratio (Tripathi *et al.*, 2006). The cation exchange sites of soil colloids in the study area was dominated by  $\text{Ca}^{+2}$ , followed by  $\text{Mg}^{+2}$ ,  $\text{K}^+$  and  $\text{Na}^+$ . The reason for domination of  $\text{Ca}^{+2}$  in the exchange sites are attributed to its relatively less mobility than other cations (Selvaraj and Naidu, 2012). The percent base saturation ranged from 45.45 to 87.60.

### Soil Genesis

Soils of study area were developed from relatively unconsolidated parent material and in the process significant changes might have occurred. Soil pedons exhibited distinct horizontal layers, some of which were clearly visible. Pedon 1 was developed from granite-gneiss parent material while pedons 2, 3 and 4 were developed from granite- gneiss mixed with calcareous murrum. Accumulation of organic matter and humus was noticed in surface horizons and extended to certain depth in all three pedons. Higher organic matter in surface horizons was due to addition of organic manures and decomposition of leaf fall, stubbles and roots in upper soil layers as part of crop management (Bhaskar *et al.*, 2004). Development of B horizon in soil pedons 2 and 3 was result of eluviation and illuviation processes. Owing to soil forming processes, transformation of soil material resulted in change of colour, structure and hardness in sub soil leading to development of cambic horizon (Bw) in pedon 2 and pedon 3, while development of argillic horizon (Bt) in pedon 1. AC pedon devoid of B horizon in low land soils (pedon 4) was due to self inversion of soil material through pedoturbation process. Fine texture in pedon 3 and 4 resulted in relatively long time presence of moisture in soil, accumulation of salts and alkaline soil pH which in turn favoured development of swell-shrink mineral (smectite group), while in pedons 1 relatively coarse texture facilitated well drained condition,

leaching of salts, acidic to neutral soil pH resulted in development of non expanding clay mineral (Kaolinite group) evidenced by lower CEC/Clay ratio.

The study area had semi-arid and monsoon type climate with distinct summer and rainy periods. The natural vegetation was perennial trees, bushes, annuals, short grasses. Further, the topography varied from moderately sloping uplands to nearly levelled low lands. The interplay of climate, vegetation and topography acting on parent material over a period of time resulted in development of distinct soil groups *viz.*, Inceptisols, Alfisols, and Vertisols in the study area.

### Soil Classification

The soils of the study area were classified to Inceptisol, Alfisol, and Vertisol orders based on morphological features, physico-chemical characters and climate of the soils (Soil Survey Staff, 2014).

Pedon 1 was classified under Alfisol at order level due to presence of argillic subsurface diagnostic horizon (Bt) with more than 35% base saturation. At suborder level it is placed under Ustalf due to presence of ustic soil moisture regime. At great group level it was named as Haplustalf because of certain features *viz.*, it did not had lithic contact with in 50 cm from surface, texture was finer than loamy fine sand in sub surface, soil temperature regime was isohyperthermic and the dry period was more than 120 cumulative days. At subgroup level the soil pedon 1 was classified as Tyic Haplustalf owing to meeting typical conditions of great group. At family level, it was classified as fine loamy, mixed and isohyperthermic Tyic Haplustalf.

Pedons 2 and 3 had cambic subsurface diagnostic horizons (Bw), which was identified by (a) absence of rock structure, (b) texture of finer than loamy fine sand, (c) absence of argillians / clay cutans, (d) consistence not brittle when moist and (e) absence of spodic / argillic / natric horizons. Hence, these two pedons were classified as

**Table 1. Summary of the morphological characteristics of the soil pedons**

Pedon no. and horizon	Depth (m)	Colour		Text-ure		Structure		Consistence		Eff env esc ence	Pores		Concreations		Roots		Boun dary	Other features	
		Dry	Moist	Text-ure	Moist	S	G	T	Dry		Moi st	Wet	Size	Qty.	Conc aconir	Size			Qty.
<b>Pedon 1 Red sandy loams on rainfed uplands</b>																			
Ap	0.00-0.13	7.5YR 4/3	7.5YR 3/4	sl	f	1	gr	sh	vfr	so & po	-	m	-	-	c	c	gw	Continuous and thick argillians observed in subsurface horizons	
Bt <sub>1</sub>	0.13-0.32	2.5YR 4/3	2.5YR 3/3	sci	m	2	sbk	sh	fr	ss & ps	-	f	-	-	f	c	gw		
Bt <sub>2</sub>	0.33-0.50	2.5YR 5/4	2.5YR 3/6	sci	m	2	sbk	h	fi	s & p	-	f	-	-	f	c	gw		
Bt <sub>3</sub>	0.51-0.64	5YR 4/6	5YR 4/6	sci	m	2	sbk	h	fi	s & p	-	f	-	-	f	c	gw		
C <sub>1</sub>	0.65- 0.86+	5YR 4/6	5YR 4/6	sci	m	2	sbk	h	fi	s & p	-	f	-	-	f	f	-		
<b>Pedon 2 Reddish yellow soils on irrigated middle lands</b>																			
Ap	0.01-0.10	7.5YR 5/3	7.5YR 4/3	sci	m	2	sbk	h	fri	ss & s p	-	m	-	f	c	m	gw		
Bw <sub>1</sub>	0.11-0.38	5YR 4/4	5YR 4/3	sci	m	3	sbk	vh	fri	s & p	-	f	-	c	f	m	gw		
Bw <sub>2</sub>	0.39-0.53	5YR 4/4	5YR 3/4	sci	m	3	sbk	vh	fi	s & p	-	f	-	c	f	f	gw		
Bw <sub>3</sub>	0.54-0.80	5YR 5/4	5YR 4/4	sci	m	2	sbk	vh	fi	vs & vp	e	f	-	conca	c	f	dw		
Bw <sub>4</sub>	0.80-0.95+	5YR 4/4	5YR 4/3	sci	m	2	abk	vh	fi	vs & vp	e	f	-	conca	c	-	-		
<b>Pedon 3 Medium black soils on irrigated mid lands</b>																			
Ap	0.01-0.18	10YR 5/4	10YR 4/4	sci	m	2	sbk	h	fri	vs & vp	-	m	-	f	c	m	gw	Narrow, moderated surface cracks observed during dry seasons	
Bw <sub>1</sub>	0.19-0.41	10YR 5/2	10YR 5/2	cl	m	3	sbk	vh	fi	vs & vp	-	f	-	c	f	m	gw		
Bw <sub>2</sub>	0.42-0.78	2.5Y 5/2	2.5YR 4/2	sc	m	3	abk	vh	vfi	vs & vp	-	f	-	c	f	f	dw		
Bw <sub>3</sub>	0.78- 1.05+	2.5Y 5/2	2.5YR 4/2	sc	m	2	abk	vh	vfi	vs & vp	e	f	-	conca	c	f	-		
<b>Pedon4 Deep black soils on irrigated low lands</b>																			
Ap	0.00-0.14	10YR 5/2	10YR 5/1	sc	m	2	sbk	h	fi	vs& vp	-	m	-	-	c	c	gw	Deep and wide surface cracks found during dry season	
Ass <sub>1</sub>	0.15-0.38	10YR 5/1	10YR 5/1	c	m	3	abk	vh	vfi	vs & vp	-	f	-	-	c	f	dw	Prominent intersecting slickensides and wedge shaped aggregates and pressure faces observed in lower horizons	
Ass <sub>2</sub>	0.39-0.72	2.5Y 4/3	2.5Y 4/2	c	m	3	abk	vh	vfi	vs & vp	-	f	-	-	c	c	dw		
Ass <sub>3</sub>	0.73-1.06	2.5Y 4/3	2.5Y 4/2	c	m	3	abk	vh	vfi	vs & vp	-	f	-	-	c	c	dw		
Ass <sub>4</sub>	1.06-1.35	2.5Y 5/1	2.5Y 4/1	c	m	3	abk	vh	vfi	vs & vp	e	f	-	conca	-	c	dw		
Ass <sub>5</sub>	1.35-1.48+	5Y 5/2	5Y 4/2	c	m	3	abk	vh	vfi	vs & vp	e	f	-	conca	-	c	-		

Texture : sl – sandy loam; scl- sandy clay loam; cl- clay loam; sc sandy clay; c-clay  
 Structure : S-size: f- fine; m-medium; c- coarse; G-grade 1-weak ; 3- strong; T-type gr- granular; sbk-sub angular blocky; abk-angular blocky;  
 Consistence : Dry: l- loose, sh- slightly hard; h- hard; vh-veryhard; Moist: s-soft; fr-friable; fi-firm ; vfi-very firm; Wet: sopo – non sticky & non plastic; ss & sp – slightly sticky & slightly plastic; s&p-sticky& plastic : vs&vp-very sticky & very plastic  
 Effervescence:e-slight effervescence; es-strong effervescence; ev- violent effervescence  
 Pores and roots : S- size; vf-very fine; f-fine; m-medium; c-coarse; Qty: vf-very few ; f-few; c-common; m-many;  
 Boundary : c-clear,s-smooth; d-diffuse; g-gradual; w-wavy

Table 2. Physical and Physico-chemical properties of soils

Pedon No. & horizon	Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	COLE	pH	EC dSm <sup>-1</sup>	Organic carbon (%)	CaCO <sub>3</sub> (%)	CEC	Exchangeable bases cmol (p <sup>+</sup> ) kg <sup>-1</sup> soil			Base saturation (%)	CEC/ clay	
												Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>			K <sup>+</sup>
<b>Pedon 1 Red sandy loams on rainfed uplands</b>																	
Ap	0.00-0.13	9.5	66.20	16.50	17.30	-	6.03	0.13	0.53	-	10.2	3.16	1.22	0.28	0.04	43.05	0.58
Bt <sub>1</sub>	0.13-0.32	6.1	59.00	17.50	23.50	-	6.51	0.17	0.30	-	13.50	4.25	1.85	0.35	0.07	48.30	0.55
Bt <sub>2</sub>	0.33-0.50	4.0	56.50	17.50	26.00	-	7.04	0.17	0.13	-	15.30	4.80	2.05	0.49	0.11	49.61	0.53
Bt <sub>3</sub>	0.51-0.64	16.3	59.00	16.00	25.00	-	7.41	0.31	0.12	-	15.85	5.30	2.20	0.55	0.09	49.40	0.57
C <sub>1</sub>	0.65- 0.86+	28.1	60.50	15.50	24.00	-	7.73	0.39	0.12	-	14.50	5.10	1.95	0.50	0.08	50.69	0.59
<b>Pedon 2 Reddish yellow soils on irrigated mid lands</b>																	
Ap	0.01-0.10	6.1	59.20	16.50	24.30	-	6.63	0.39	0.45	-	16.35	6.35	1.66	0.50	0.07	52.48	0.67
Bw <sub>1</sub>	0.11-0.38	4.6	56.80	17.10	26.10	-	7.14	0.43	0.365	-	17.50	7.75	1.78	0.55	0.09	58.09	0.65
Bw <sub>2</sub>	0.39-0.53	3.3	54.80	16.70	28.50	-	7.36	0.40	0.291	-	18.30	8.30	2.18	0.68	0.12	61.64	0.62
Bw <sub>3</sub>	0.54-0.80	4.1	56.55	16.20	27.25	-	7.68	0.47	0.253	-	19.80	8.95	2.95	0.80	0.13	64.80	0.65
Bw <sub>4</sub>	0.80-0.95+	7.5	59.60	14.10	26.30	-	8.09	0.58	0.213	1.2	20.65	8.55	2.92	0.75	0.15	61.99	0.66
<b>Pedon 3 Medium black soils on irrigated mid lands</b>																	
Ap	0.01-0.18	3.68	54.10	14.10	31.80	0.02	7.33	0.43	0.50		23.60	9.15	2.70	0.92	0.13	56.06	0.73
Bw <sub>1</sub>	0.19-0.41	2.50	50.85	15.00	34.15	0.03	7.65	0.49	0.291		25.40	11.25	2.55	1.18	0.15	60.63	0.74
Bw <sub>2</sub>	0.42-0.78	2.15	53.40	13.20	33.40	0.03	8.26	0.97	0.253		24.90	14.35	3.10	0.97	0.15	77.11	0.75
Bw <sub>3</sub>	0.78- 1.05+	4.20	51.30	14.10	34.60	0.03	8.31	1.22	0.180	2.6	26.50	16.25	2.90	1.40	0.18	78.23	0.77
<b>Pedon 4 Deep black soils on irrigated low lands</b>																	
Ap	0.00-0.14	1.4	46.00	18.90	35.10	0.06	7.81	0.48	0.75	-	29.60	19.60	2.58	0.95	0.10	78.48	0.84
Ass <sub>1</sub>	0.15-0.38	0.8	45.50	17.00	37.50	0.10	8.16	0.65	0.302	-	30.50	20.30	3.04	1.32	0.18	81.44	0.81
Ass <sub>2</sub>	0.39-0.72	1.0	44.40	17.00	38.60	0.11	8.12	0.81	0.231	-	33.50	23.15	3.35	1.85	0.12	83.19	0.87
Ass <sub>3</sub>	0.73-1.06	0.8	40.85	18.90	40.25	0.13	8.04	1.04	0.183	1.5	32.50	23.60	3.60	1.15	0.12	87.60	0.81
Ass <sub>4</sub>	1.06-1.35	2.0	40.70	17.50	41.80	0.13	8.26	1.20	0.183	3.8	34.30	24.00	3.80	2.05	0.18	84.64	0.82
Ass <sub>5</sub>	1.35-1.48+	4.6	41.50	16.00	42.50	0.13	8.35	1.35	0.154	5.3	32.50	23.15	3.35	1.80	0.12	85.75	0.79

COLE- Coefficient of linear extensibility; EC - Electric conductivity; CEC; Cation exchange capacity; cmol(p<sup>+</sup>) - centi moles positive charge

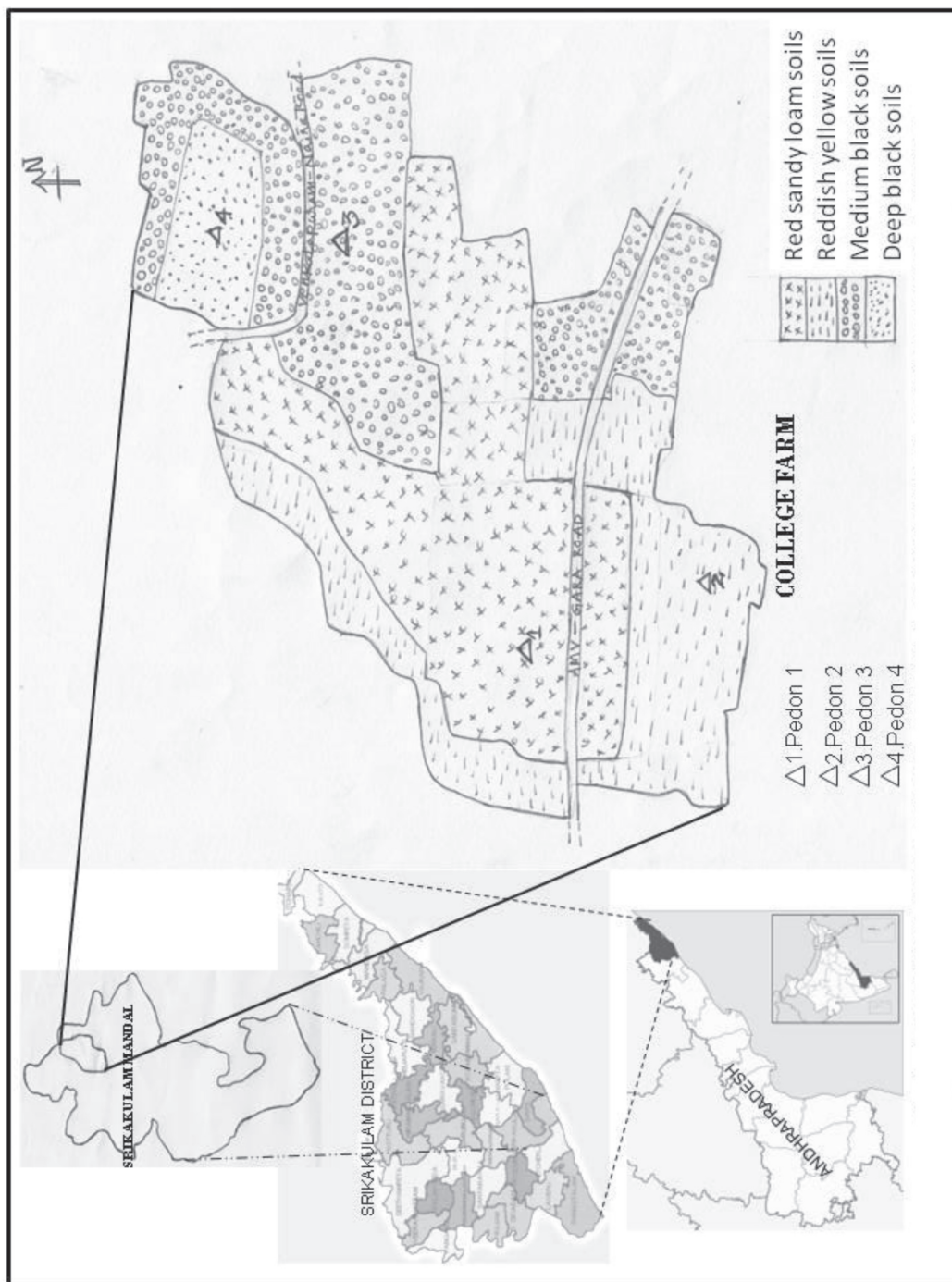


Fig.1. Location map of pedons at Agricultural College Farm, Naira

Inceptisol at order level. Further, these two pedons grouped under ustepts at sub-order level due to ustic soil moisture regime and Haplustepts at great group level because these pedons did not have duripan or calcic horizon and base saturation was more than 60% at depth between 0.25 to 0.75m from the surface. Further, pedon 2 did not have lithic contact with in 50cm from the soil surface and absence of vertic properties hence it is logically classified as Typic Haplustepts. Pedon 3 had vertic properties such as presence of surface cracks of more than 5mm during summer and the coefficient of linear extensibility (COLE) at sub surface 0.02-0.03, hence, it is logically classified at subgroup level as Vertic Haplustepts. At family level, pedon 2 was placed under loamy, mixed, iso-heperthermic Typic Haplustepts, while pedon 3 was classified as clayey-smectitic- isohyperthermic Vertic Haplustepts.

Pedon 4 was classified as Vertisol at order level because of vertic properties such as presence of deep wide surface cracks during summer and wedge shaped aggregates and intersecting slicken sides in subsurface layers. At suborder level it was classified into ustert due to the soil moisture regime was ustic. At great group level the pedon was named as Haplustert since it does not have features of either salic, gypsic or calcic horizon with in 100 cm depth. At subgroup level it was named as Typic Haplustert as it does not have extra grades or intra grades. At family level the pedon was placed under fine clayey, smectitic (evidenced by presence deep and wide surface cracks during summer, high COLE and CEC/ clay ratio was more than 0.7), iso-hyperthermic Typic Haplustert.

## CONCLUSION

The climate of the study area was semi-arid with distinct dry and wet periods. The soil texture ranged from sandy loam to clay, acidic to alkaline in reaction, non-saline, high base status, medium to high CEC,  $\text{Ca}^{2+}$  was the dominant cation on exchange complex followed by  $\text{Mg}^{2+}$ ,  $\text{Na}^+$  and  $\text{K}^+$ .

The CEC/ clay ratio was low in pedon 1, medium in pedon 2, while it was high in pedon 3 and pedon 4 indicating dominance of 1:1 type, mixed type and 2:1 type clay minerals, respectively. Deep and wide surface cracks and intersecting slicken sides in subsurface were found in pedon 4 during summer months. The COLE ranged from 0.02 to 0.03 in pedon 3 and 0.06- 0.13 in pedon 4. The organic carbon content was low to medium and found decreasing in trend with soil depth. Calcareous murrum was found in lower layers of pedon 3 and pedon 4. Topography, climate and parent material played important role in genesis of these soils. The soils were classified as Typic Haplustalf, Typic Haplustepts, Vertic Haplustepts and Typic Haplusterts at subgroup level.

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## EFFECT OF WEED MANAGEMENT PRACTICES ON GROWTH AND YIELD OF MUNGBEAN (*Vigna radiata* L.)

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### ABSTRACT

Field experiment to study the effect of weed management on growth and yield of mungbean was conducted during *kharif* seasons of 2016 and 2017. The experiment comprising of nine treatments was laid out in a randomized block design (RBD) and replicated thrice. Significantly higher growth parameters and yield attributes was observed with manual hand weeding at 20 DAS and 35-40 DAS. Among the different herbicidal weed management treatments, Clodinafop propargyl 8% + Aceflorfen Sodium 16.5% @ 187.5 g ha<sup>-1</sup> at 15 DAS-20 DAS recorded higher growth and yield attributes. Significantly higher grain yield, gross returns, net returns and B:C ratio was recorded with two manual hand weeding at 20 DAS and 35 DAS-40 DAS. Therefore, in order to achieve higher grain yield in mungbean effective weed control can be achieved by hand weeding at 20 DAS and 35 DAS -40 DAS during the crop growth period with an alternative pre-emergence application of Pendimethalin 30EC + imazethapyr 2EC @ 0.75 kg ha<sup>-1</sup>.

### INTRODUCTION

Mungbean is one of the most important and extensively cultivated crop in India, which is cultivated in arid and semi arid region. India is the largest producer of mungbean with 2.2 Mt of production in an area of 4.3 Mha with an average productivity of 502 kg ha<sup>-1</sup>. Whereas, in Andhra Pradesh, the average production of mungbean in an area of 1.3 Mha is 0.67 Lakh tonnes with productivity of 500 kg ha<sup>-1</sup> in 2016-17. It contains about 25% protein, 3.5% minerals, 4.1% fibre and 56.7% carbohydrates. In spite of the importance of this crop in our daily diet average productivity of this crop is very low in India as well as Andhra Pradesh. The low production of this crop is mainly due to crop weed competition and other reasons like sprouting of seeds on plants at harvesting stage due to rains in *Kharif*. Being a rainy season crop, it is invaded by a large number of fast growing weeds.

Hand weeding is the common cultural practice being followed in mungbean. Manual weeding at right stage is difficult, time consuming and expensive due to intermittent rainfall during rainy

season and scanty labour availability. Furthermore, weather conditions do not permit timely hand weeding due to wet field conditions. Under such situation, herbicides use with suitable dose remains the pertinent choice for controlling the weeds. Therefore, the study with various herbicides along with hand weeding and untreated check was conducted.

### MATERIAL AND METHODS

The field experiment was carried out during *Kharif*, 2016 and *Kharif*, 2017 at Regional Agricultural Research Station, Lam, Guntur. The experimental site is located at 16°18'N latitude, 80°29' E longitude and an altitude of 33m above MSL. Soil of the experimental site was deep black clay loam in texture. Nine treatments were arranged in a randomized block design (RBD) with three replications during both the years. The crop was sown on 8<sup>th</sup> July, 2016 and 5<sup>th</sup> July, 2017. The seeds were manually placed in furrows at plant to plant distance of 10 cm. Full dose of recommended nitrogen and phosphorus (20-50-0 kg NPK ha<sup>-1</sup>) was drilled before sowing. The test variety used for the experiment was

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'IPM 2-14'. In case of hand weeding, weeds were removed manually with a *kurpa* (hand tool) at 20 DAS and 35-40 DAS. In case of unweeded check plot, weeds were allowed during the whole crop season. Herbicide spraying was done with a knapsack sprayer using a spray volume of 500 l of water per ha. Care was taken to ensure uniform application of herbicides in each plot as per treatment. During both the years, the crop was harvested on 19<sup>th</sup> September, 2016 and 15<sup>th</sup> September, 2017. The crop has received 317.6 mm and 366.2 mm rainfall with 22 and 32 rainy days during 2016 and 2017, respectively during crop growth period. The data on plant growth and grain yield was recorded as per the standard procedure and economics calculations were done on the basis of prevailing market prices of input and output. The data recorded on different observations were tabulated and analyzed statistically by using the Analysis of Variance (ANOVA) techniques as suggested by Gomez and Gomez (1984).

## RESULTS AND DISCUSSION

### Weed growth

Weed flora emerged were grasses such as *Cynodon dactylon*, *Dactyloctenium aegyptium*, *Echinichloa colona*, *Digitaria sanguinalis*, *Brachiaria* spp., sedges such as *Cyperus rotundus* and broad leaved weeds *viz.*, *Amaranthus viridis*, *Digera arvensis*, *Parthenium hysterophorus*, *Phyllanthus niruri*, *Trianthema portulacastrum*, *Acalypha indica* and *Abutilon indicum*.

In the study, hand weeding at 20 DAS and 35-40 DAS (13.8 Nos m<sup>-2</sup>) resulted in lowest weed density. However, treatments Pendimethalin 30EC @ 1.0 kg ha<sup>-1</sup> PE + imazethapyr 2EC @ 0.75 kg ha<sup>-1</sup> PE (17.9 Nos m<sup>-2</sup>) and Imazethapyr 10% SL @ 55 g ha<sup>-1</sup> at 15-20 DAS (25.5 Nos m<sup>-2</sup>) were found to be statistically on a par with treatment of hand weeding at 20 DAS and 35-40 DAS (Table 1). This might be due to control of weeds during early growth stage by hand weeding and pre emergence application of herbicides which prevented the emergence of

monocot and grassy weeds by inhibiting root and shoot growth, while post emergence application of herbicide was responsible for inhibition of acetolactate synthase (ALS) or acetohydroxy acid synthase (AHAS) in broad leaved weeds which caused destruction of these weeds at 3-4 leaf stage. Similar results of lowest weed density and highest weed control efficiency with hand weeding twice at 20 DAS and 40 DAS was reported by Komal *et al.* (2015) in *Kharif* mungbean at Bikaner.

Among the different treatments (Table 1), significantly highest dry weight of weeds (88.1 g m<sup>-1</sup>) was recorded under weedy check treatment. However, it was found that among the different weed management practices, treatment T<sub>9</sub> in which hand weeding was completed at 20 DAS and 35-40 DAS, recorded significantly minimum dry weight of weed (9.2 g m<sup>-1</sup>) which was statistically on a par with Imazethapyr 10% SL @ 55 g ha<sup>-1</sup> at 15-20 DAS (12.7 g m<sup>-1</sup>), Pendimethalin 30EC @ 1.0 kg ha<sup>-1</sup> PE + Imazethapyr 2EC @ 0.75 kg ha<sup>-1</sup> PE (16.4 g m<sup>-1</sup>) and Clodinafop propargyl 8% + Aceflorfen Sodium 16.5% @ 187.5 g ha<sup>-1</sup> at 15-20 DAS (18.9 g m<sup>-1</sup>) (Table 1). Minimum dry weight of weeds in different weed management treatments with weed free conditions might be due to effective weed control obtained under hand weeding and pre emergence application of herbicides at initial and early crop growth stage, which resulted into the lowest weed count and reduced total dry weight of weeds, thus, resulting in the rapid growth of mungbean and dense crop canopy that might have suppressed weed growth by smothering effect. Singh *et al.* (2015) and Chaudhari *et al.* (2016) have also confirmed the similar findings of lowest dry matter of weeds and maximum weed control efficiency with post-emergence application of Imazethapyr 10% SL @ 55 g ha<sup>-1</sup> at 15-20 DAS which was closely followed by Pendimethalin 30EC @ 1.0 kg ha<sup>-1</sup> PE + Imazethapyr 2EC @ 0.75 kg ha<sup>-1</sup> PE.

Table 1. Effect of herbicidal weed management practices on weed dynamics in *kharif* mungbean (2016-2017)

Treatments	Weed density (No. m <sup>-2</sup> ) at 45 DAS			Weed dry weight (g m <sup>-1</sup> ) at 45 DAS			Weed control efficiency (%)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
1. Weedy check	99.3	78.3	88.8	101.3	74.9	88.1	00.0	00.0	0.0
2. Pendimethalin 30EC @ 1.0 kg ha <sup>-1</sup> PE	54.0	30.3	42.2	64.7	36.0	50.4	36.1	52.0	44.1
3. Pendimethalin 30EC @ 1.0 kg ha <sup>-1</sup> PE + imazethapyr 2EC @ 0.75 kg ha <sup>-1</sup> PE	16.7	19.0	17.9	22.7	10.0	16.4	77.6	86.6	82.1
4. Imazethapyr 10% SL @ 55 g ha <sup>-1</sup> at 15-20 DAS	22.0	29.0	25.5	20.0	5.4	12.7	80.3	92.8	86.6
5. Imazamox 35WG + Imazethapyr 10SL @ 40 g ha <sup>-1</sup> at 15 DAS -20 DAS	37.3	54.3	45.8	30.7	38.6	34.7	69.7	48.	59.1
6. Imazamox 35WG + Imazethapyr 10SL @ 60 g ha <sup>-1</sup> at 15 DAS -20 DAS	22.3	43.7	33.0	22.7	35.2	29.0	77.6	53.0	65.3
7. Clodinafop propargyl 8% + Aceflorofen Sodium 16.5% @ 125 g ha <sup>-1</sup> at 15-20 DAS	69.3	42.0	55.7	47.3	34.3	40.8	53.3	54.2	53.8
8. Clodinafop propargyl 8% + Aceflorofen Sodium 16.5% @ 187.5 g ha <sup>-1</sup> at 15-20 DAS	30.0	32.3	31.2	16.7	21.1	18.9	83.5	71.8	77.7
9. Two manual hand weeding at 20 DAS and 35 DAS -40 DAS	9.3	18.3	13.8	12	6.4	9.2	88.2	91.4	89.8
	5.8	4.5	4.6	7.2	3.1	4.5	-	-	-
SEM±	17.5	13.5	13.5	21	9.3	13.3	-	-	-
CD (P ≤ 05)	25.3	20.2	22.8	33	18.4	25.7	-	-	-
CV (%)									

Various weed management treatments showed better weed control efficiency. The highest weed control efficiency (89.8%) was recorded under manual hand weeding at 20 DAS and 35-40 DAS followed by treatments Imazethapyr 10% SL @ 55 g ha<sup>-1</sup> at 15-20 DAS (86.6%), Pendimethalin 30EC @ 1.0 kg ha<sup>-1</sup> PE + Imazethapyr 2EC @ 0.75 kg ha<sup>-1</sup> PE (82.1%) and Clodinafop propargyl 8% + Aceflorofen Sodium 16.5% @ 187.5 g ha<sup>-1</sup> at 15-20 DAS (77.7%) (Table 1). The higher weed control efficiency recorded under weed management treatments might be due to periodical removal of weeds (by hand weeding or herbicidal control) resulting in remarkable reduction in weed population and ultimately less dry weight of weeds. Singh *et al.* (2015) and Venkata Rao *et al.* (2017) also reported similar results of the higher WCE by manual weeding twice at 20 DAS and 35-40 DAS in *Kharif* mungbean.

### Growth Parameters

The growth parameters such as plant height and branches plant<sup>-1</sup> were significantly influenced by all the weed management practices in both the years of the study, however, pooled analysis indicated that branches plant<sup>-1</sup> were significantly influenced by weed management practices (Table 1). However, plant height was not significantly influenced by different weed management practices. Whereas, The data on number of branches plant<sup>-1</sup> showed significant variation due to weed management practices. Significantly higher number of branches plant<sup>-1</sup> (4.5) were recorded with two manual hand weedings at 20 DAS and 35-40 DAS and statistically superior over all other weed management practices. This might be due to control of weeds during early growth stages and the crop covers soil surface and smothers the growth of weeds in later stages. Komal *et al.* (2015) also reported similar findings of higher plant height and higher drymatter accumulation at harvest.

### Yield Attributes and Yield

The yield attributes were significantly influenced by the weed management practices which

were adopted in the study. The maximum number of pods plant<sup>-1</sup> (18.6) were recorded with two manual hand weedings at 20 DAS and 35-40 DAS and found significantly superior over all other weed management practices. Significantly highest pod length (7.9 cm) of mungbean was recorded with two manual hand weedings at 20 DAS and 35-40 DAS and found statistically on par with treatments Clodinafop propargyl 8% + Aceflorofen Sodium 16.5% @ 187.5 g ha<sup>-1</sup> at 15-20 DAS (7.7 cm), Imazamox 35WG + Imazethapyr 10SL @ 60 g ha<sup>-1</sup> at 15-20 DAS (7.6 cm) and Imazethapyr 10% SL @ 55 g ha<sup>-1</sup> at 15-20 DAS (7.6 cm) and significantly superior over other treatments. Whereas, maximum test weight was recorded with two manual hand weedings at 20 DAS and 35-40 DAS and found statistically on par with treatment Clodinafop propargyl 8% + Aceflorofen Sodium 16.5% @ 187.5 g ha<sup>-1</sup> at 15-20 DAS (7.7 cm) and significantly superior over all other treatments. The increase in yield attributes under two manual hand weedings at 20 DAS and 35-40 DAS can be attributed due to the reduction in weed competition with the crop which ultimately favoured better environment for growth and development of the crop. Deshmukh *et al.* (2018) also indicated similar results of more yield attributes with manual weeding twice at 20 DAS and 35-40 DAS.

The maximum grain yield (635 kg ha<sup>-1</sup>) was recorded with hand weeding at 20 DAS and 35-40 DAS which was statistically superior over all other treatments (Table 3). This might be due to minimizing the competition of weeds with main crop for resources *viz.*, space, light, nutrients and moisture with adoption of effective weed control methods. Thus, reduced crop weed competition resulted in overall improvement in crop growth and subsequently better development of reproductive parts and translocation of photosynthates to the sink ultimately resulting in increased grain yield. Among the herbicide weed control treatments, Pendimethalin 30EC @ 1.0 kg ha<sup>-1</sup> PE + Imazethapyr 2EC @ 0.75 kg ha<sup>-1</sup> PE was found more effective and recorded higher grain yield

Table 2. Effect of weed management practices on growth and yield attributes of mungbean

Treatments	Plant height (cm)			Number of branches plant <sup>-1</sup>			Number of pods plant <sup>-1</sup>			Pod length (cm)			Test weight (g)		
	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean
	1. Weedy check	53.1	62.6	57.9	2.6	2.2	2.5	11.7	8.5	10.1	7.1	6.6	6.9	3.1	3.4
2. Pendimethalin 30EC @ 1.0 kg ha <sup>-1</sup> PE	44.7	78.7	61.8	3.5	2.8	3.2	14.9	11.9	13.4	7.8	6.9	7.4	3.5	3.7	3.6
3. Pendimethalin 30EC @ 1.0 kg ha <sup>-1</sup> PE + imazethapyr 2EC @ 0.75 kg ha <sup>-1</sup> PE	45.5	74.7	60.1	4.2	2.9	3.6	18.1	12.1	15.1	8.0	7.0	7.5	3.7	3.6	3.6
4. Imazethapyr 10% SL @ 55 g ha <sup>-1</sup> at 15 DAS -20 DAS	48.6	82.6	65.6	3.7	4.0	3.9	16.9	14.6	15.8	7.8	7.4	7.6	3.4	3.5	3.5
5. Imazamox 35WG + Imazethapyr 10SL @ 40 g ha <sup>-1</sup> at 15-20 DAS	48.0	78.9	63.5	3.6	3.6	3.6	15.0	10.8	12.9	7.3	7.4	7.4	3.5	3.5	3.6
6. Imazamox 35WG + Imazethapyr 10SL @ 60 g ha <sup>-1</sup> at 15-20 DAS	50.9	79.3	65.1	4.0	3.5	3.8	17.7	12.7	15.2	7.7	7.6	7.6	3.6	3.6	3.6
7. Clodinafop propargyl 8% + Aceflorfen Sodium 16.5% @ 125 g ha <sup>-1</sup> at 15 DAS-20 DAS	48.9	73.1	61.0	4.1	3.1	3.6	14.9	11.6	13.3	7.5	7.0	7.2	3.6	3.7	3.6
8. Clodinafop propargyl 8% + Aceflorfen Sodium 16.5% @ 187.5 g ha <sup>-1</sup> at 15 DAS-20 DAS	50.1	79.5	64.8	4.3	3.8	4.0	17.9	13.8	15.9	7.9	7.4	7.7	3.9	3.6	3.7
9. Two manual hand weeding at 20 DAS and 35-40 DAS	49.1	84.4	66.8	4.6	4.4	4.5	21.7	15.5	18.6	8.1	7.7	7.9	3.9	3.8	3.9
SEm±	1.58	3.83	2.29	0.15	0.27	0.16	0.92	1.04	0.76	0.18	0.17	0.12	0.09	0.1	0.09
CD (P ≤ 0.05)	4.7	11.4	NS	0.5	0.8	0.5	2.8	3.1	2.3	0.5	0.5	0.4	0.3	NS	0.3
CV (%)	5.6	8.6	6.3	6.8	13.8	7.5	9.7	14.7	9.1	4.0	4.1	2.8	4.6	4.7	4.1

**Table 3. Effect of weed management practices on grain yield and economics of mungbean**

Treatments	Grain yield (kg ha <sup>-1</sup> )			Cost of cultivation (□ha <sup>-1</sup> )			Gross returns (□ha <sup>-1</sup> )			Net returns (□ ha <sup>-1</sup> )			B:C ratio		
	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean
	1. Weedy check	269	483	376	25650	26500	26075	16678	29946	23312	-8972	3446	-2763	-0.35	0.13
2. Pendimethalin 30EC @ 1.0 kg ha <sup>-1</sup> PE	349	615	482	27770	28620	28195	21638	38130	29884	-6132	9510	1689	-0.22	0.33	0.06
3. Pendimethalin 30EC @ 1.0 kg ha <sup>-1</sup> PE + imazethapyr 2EC @ 0.75 kg ha <sup>-1</sup> PE	416	697	557	28150	29000	28575	25792	43214	34503	-2358	14214	5928	-0.08	0.49	0.21
4. Imazethapyr 10% SL @ 55 g ha <sup>-1</sup> at 15-20 DAS	373	714	544	27275	28125	27700	23126	44268	33697	-4149	16143	5997	-0.15	0.57	0.22
5. Imazamox 35WG + Imazethapyr 10SL @ 40 g ha <sup>-1</sup> at 15-20 DAS	332	587	460	27485	28335	27910	20584	36394	28489	-6901	8059	579	-0.25	0.28	0.02
6. Imazamox 35WG + Imazethapyr 10SL @ 60 g ha <sup>-1</sup> at 15-20 DAS	334	608	471	27900	28750	28325	20708	37696	29202	-7192	8946	877	-0.26	0.31	0.03
7. Clodinafop propargyl 8% + Aceflorfen Sodium 16.5% @ 125 g ha <sup>-1</sup> at 15-20 DAS	351	643	497	27850	28700	28275	21762	39866	30814	-6088	11166	2539	-0.22	0.39	0.09
8. Clodinafop propargyl 8% + Aceflorfen Sodium 16.5% @ 187.5 g ha <sup>-1</sup> at 15-20 DAS	358	672	515	28400	29250	28825	22196	41664	31930	-6204	12414	3105	-0.22	0.42	0.11
9. Two manual hand weeding at 20 DAS and 35-40 DAS	483	786	635	28650	29500	29075	29946	48732	39339	1296	19232	10264	0.05	0.65	0.35
SEM±	19.53	31.69	23.14	-	-	-	-	-	-	-	-	-	-	-	-
CD (P ≤ 0.05)	59	95	68	-	-	-	-	-	-	-	-	-	-	-	-
CV (%)	9.3	8.5	8.9	-	-	-	-	-	-	-	-	-	-	-	-

(557 kg ha<sup>-1</sup>) and which was at par with treatments Imazethapyr 10% SL @ 55 g ha<sup>-1</sup> at 15-20 DAS (544 kg ha<sup>-1</sup>) and Clodinafop propargyl 8% + Aceflorofen Sodium 16.5% @ 187.5 g ha<sup>-1</sup> at 15 DAS-20 DAS (515 kg ha<sup>-1</sup>). This might be due to minimizing the competition of weeds with main crop for resources viz., space, light, nutrients and moisture with adoption of effective weed control methods. Thus, reduced crop-weed competition resulted in overall crop growth as reflected by growth parameters and yield attribute. In addition, the least weed population and dry weights of weeds were registered under these treatments are responsible for better seed yield. The per cent increase in grain yield under weed management practices (T<sub>2</sub>-T<sub>9</sub>) is to the tune of 38.9% over weedy check. Similar findings of higher grain yields with manual weeding twice at 20 DAS and 35-40DAS and herbicide application Pendimethalin 30EC @ 1.0 kg ha<sup>-1</sup> PE + Imazethapyr 2EC @ 0.75 kg ha<sup>-1</sup> as PE were reported by Komal *et al.* (2015) and Venkata Rao *et al.* (2017).

### ECONOMICS

The monetary returns were found to be significantly influenced by different weed control treatments (Table 3). Economics of different weed control treatments showed that two manual hand weedings at 20 DAS and 35-40 DAS gave the maximum gross returns, net returns and B:C ratio. Among herbicide treatments, highest gross returns (39,339 ha<sup>-1</sup>), net returns (10,264 ha<sup>-1</sup>) and B:C ratio (0.35) were obtained with application of Imazethapyr 10% SL @ 55 g ha<sup>-1</sup> at 15 DAS-20 DAS followed by Pendimethalin 30EC @ 1.0 kg ha<sup>-1</sup> PE + Imazethapyr 2EC @ 0.75 kg ha<sup>-1</sup> PE during both the years of 2016 and 2017. This might be due to higher grain yield obtained with the respective treatments. The lowest gross returns, net returns and B:C ratio were obtained with weedy check might be due to higher

weed infestation during initial stages of crop growth which had profound weed competition resulting in drastic reduction in grain yield of mungbean. Singh *et al.* (2015) and Venkata Rao *et al.* (2017) also reported similar findings of higher B:C ratio with manual weeding twice at 20 DAS and 35-40 DAS.

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## THERMAL AND RAIN WATER USE EFFICIENCY IN PIGEONPEA BASED INTERCROPPING SYSTEM UNDER RAINFED CONDITIONS

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### ABSTRACT

Computation of agrometeorological indices *i.e.* growing degree days (GDD), heat use efficiency (HUE), helio thermal use efficiency (HTUE), radiation use efficiency (RUE) and rain water use efficiency of pigeonpea based inter cropping system under rainfed conditions was carried out for two years. The experiment consisting of four sole crops *viz.*, pigeonpea, ragi, korra and blackgram and three inter crops *viz.*, pigeonpea+ragi, pigeonpea+korra and pigeonpea+blackgram in the ratio 1:5 was sown in randomized block design with three replications. It was recorded that the heat use efficiency (HUE), helio thermal use efficiency (HTUE), radiation use efficiency (RUE) and rain water use efficiency (RWUE) significantly influenced the dry matter production and grain yield under different pigeonpea based cropping stems under rainfed conditions of Krishna agro-climatic zone of south coastal Andhra Pradesh. Among the sole and intercrops, pigeonpea sole and pigeonpea+blackgram in the ratio of 1:5 significantly recorded higher heat use efficiency (HUE), helio thermal use efficiency (HTUE), radiation use efficiency (RUE), rain water use efficiency (RWUE) and grain yield.

### INTRODUCTION

The key to sustainable agriculture probably lies in increased output per unit area together without expansion of arable land area. Under this crop management process, cultivation of more than two crops in a definite row or without row in a single piece of land is being practiced. Inter cropping is one of the option to gain the maximum productivity without land expansion from unit area to meet the double digit growth rate. Ofori and Stern (1987) reported that the inter cropping is recognized as a common cropping system in tropics and sub tropics. Risk to farmer is comparatively less in multiple cropping system and several studies on multiple cropping systems indicated that the risk to farmers is lower in multiple cropping than sole crop (Mukharje *et al.*, 2008).

Increased returns from farm unit area by increasing the cropping intensity without arable land expansion thereby increases the economic returns of the rainfed farmer. The main reason for using multiple cropping is to utilize the space and labour

efficiently (Baldy and Stigler, 1997) and further, biophysical reasons include better utilization of environmental factors, greater yield productivity in variable environments and soils conservation practice. In case of tropics and subtropics weather elements such as temperature and its derivatives *viz.*, photo-thermal, helio-thermal and intercepted radiation, in addition to rain water and its utilisation by different crops are important factors for growth and yield of any crop or inter crops under rainfed conditions (Ratnam *et al.*, 2014). Conversely, excessive rain may shift the balance between vegetative and reproductive growth towards excessive development, thus, delaying the crop maturity and reducing the yield. Keeping these in view, the study was conducted on radiation use and rain water use efficiency in pigeonpea based inter cropping system under rainfed conditions.

### MATERIAL AND METHODS

Field experiment was conducted during 2016-17 and 2017-18 at Regional Agricultural Research Station, Guntur (latitude: 16°18' N,

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longitude 80° 29' E), Andhra Pradesh. The climate is subtropical with annual rainfall of 950 mm. The soil of the experiment field was clay loam in texture, neutral to slightly alkaline in reaction (pH 7.8 to 8.2) medium in organic carbon content (0.51%), low in available K (110 kg/ha). The trial was laid out in RBD with three replications. The treatments consisted of four sole crops viz., T<sub>1</sub>: pigeonpea; T<sub>2</sub>: Ragi; T<sub>3</sub>: Korra; T<sub>4</sub>: Blackgram and three inter crops viz., T<sub>5</sub>: pigeonpea+korra; T<sub>6</sub>: pigeonpea+ragi and T<sub>7</sub>: pigeonpea+blackgram. During the experiment, crop received an amount of 426 mm rainfall in 31 rainy days, mean maximum temperature (T max) of 33.6 °C, mean minimum temperature of (Tmin) 20.4 °C, bright sun shine hours of six (Fig.1). Sowing was done by dibbling one seed/hill the gap filling was done on ten days after sowing. Pigeonpea variety 'LRG-52'; ragi variety 'champavathi'; korra variety 'suryanandi' and blackgram variety 'PU31' were sown on 27<sup>th</sup> standard meteorological week and harvested on 6<sup>th</sup> standard meteorological week. Entire phosphorus was applied in the form of single super phosphate and nitrogen and potassium were applied as basal in the form of urea and muriate of potash. Necessary and need based plant protection was taken up during the crop growth. The data pertaining to temperature, other temperature derivative weather parameters and yield was collected and computed the growing degree days (GDD), helio thermal units (HTU), helio thermal use efficiency (HTUE), heat use efficiency (HUE), radiation use efficiency (RUE) and rain water use efficiency by following equations as proposed by (Sreenivas *et al.*, 2008). The base temperature (T<sub>b</sub>) 10.0°C (Ratnam *et al.*, 2014) was used for calculation of GDD.

$$GDD = \left[ \frac{\sum (T_{max} + T_{min})}{2} \right] - T_{base}$$

Heat use efficiency (HUE) = Yield ÷ ∑ GDD

Helio thermal units (HTU) = GDD x SSH (bright)

Helio thermal use efficiency (HTUE) (kg ha<sup>-1</sup> °C<sup>-1</sup> hr<sup>-1</sup>) = Yield ÷ HTU

Radiation use efficiency (RUE) = yield ÷ Solar radiation (mJm<sup>-2</sup>)

Solar radiation = 1BSSH = 3.66 (mJm<sup>-2</sup>)

Rain water use efficiency (RWUE) = Yield (kg ha<sup>-1</sup>) ÷ Total rainfall (mm)

## RESULTS AND DISCUSSION

### Drymatter accumulation

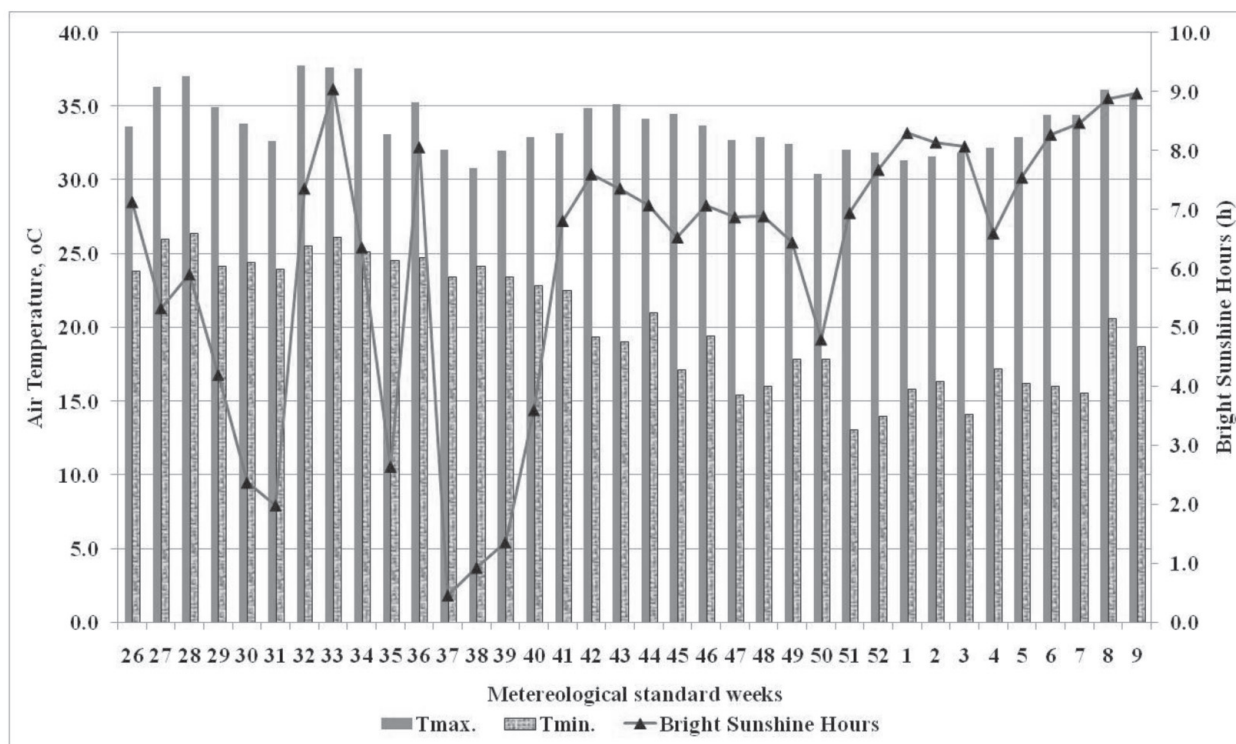
Drymatter production has significantly varied with sole and intercrops during the experimentation. Among the sole crops, ragi significantly accumulated more dry matter (6885 kg ha<sup>-1</sup>) followed by korra (4521 kg ha<sup>-1</sup>). Among the inter crops cultivated at 1:5 ratio, pigeonpea+ragi significantly accumulated highest drymatter (8715 kg ha<sup>-1</sup>) followed by pigeonpea+korra (6822 kg ha<sup>-1</sup>) (Table 1). More accumulation of drymatter in pigeonpea sole crop and pigeonpea+ragi might be due to response to higher radiation and rain water use efficiency (Ratnam *et al.*, 2014).

### Grain Yield

Grain yield has significantly differed with sole and intercrops during the experiment. Among the sole crops, pigeonpea significantly produced higher grain yield (1800 kg ha<sup>-1</sup>) followed by korra (833 kg ha<sup>-1</sup>). Among the intercrops tried at 1:5 ratio, pigeonpea+blackgram significantly produced higher grain yield (3100 kg ha<sup>-1</sup>) followed by pigeonpea+korra (2700 kg ha<sup>-1</sup>) (Table 1). The reason for higher grain yield is that pigeonpea might have more radiation use efficiency coupled with rain water use efficiency which thus resulting in better utilisation of moisture during the growing period. According to Ratnam *et al.* (2014), mean maximum and minimum temperature as well as rainfall has significant positive influence on yield.

Table 1. Thermal and rain water use efficiency of pigeonpea based inter cropping system under rainfed conditions

Treatment	Cumulative GDD	Cumulative active Cu SSH	Cumulative active HTU	Yield (kg ha <sup>-1</sup> )	HTUE (kg/HTU) (kg-ha <sup>-2</sup> )	Dry matter (HTU)	HUE (mJm <sup>-1</sup> )	Solar radiation (mjm <sup>-2</sup> )	RUE (mm <sup>-1</sup> )	RWUE (kg ha <sup>-1</sup> )
T <sub>1</sub> : Pigeonpea	6213	1878	2475	1800	0.73	3674	0.29	6761	0.27	4.74
T <sub>2</sub> : Ragi	6213	1878	2475	533	0.22	6885	0.09	6761	0.08	1.40
T <sub>3</sub> : Korra	6213	1878	2475	833	0.34	4521	0.13	6761	0.12	2.20
T <sub>4</sub> : Blackgram	6213	1878	2475	370	0.15	879	0.06	6761	0.05	1.00
T <sub>5</sub> : Pigeonpea equivalent yield (pigeonpea+Ragi)	6213	1878	2475	2300	0.93	8715	0.37	6761	0.34	6.10
T <sub>6</sub> : Pigeonpea equivalent yield (pigeonpea+ Korra)	6213	1878	2475	2700	1.10	6822	0.43	6761	0.40	7.10
T <sub>7</sub> : Pigeonpea equivalent yield (pigeonpea+blackgram)	6213	1878	2475	3100	1.24	4615	0.49	6761	0.48	8.10
<b>SEM ±</b>	-	-	-	102.09	0.04	362.12	0.02	-	0.02	0.27
<b>CD (P ≤ 0.05)</b>	-	-	-	<b>314.56</b>	<b>0.13</b>	<b>1115.74</b>	<b>0.05</b>	-	-	<b>0.83</b>
<b>CV %</b>	-	-	-	<b>10.7</b>	<b>10.7</b>	<b>12.2</b>	<b>10.8</b>	-	-	<b>10.6</b>



**Fig. 1. Temporal variation of air temperature and bright sun shine hours during crop growing period**

### Radiation use efficiency

Radiation use efficiency has significantly differed with sole crop and intercrops during the experiment. Among the sole crops, pigeonpea significantly showed higher radiation use efficiency ( $0.27 \text{ mJm}^{-1}$ ) followed by kora. Among the intercrops, pigeonpea+blackgram significantly showed higher radiation use efficiency ( $0.48 \text{ mJm}^{-1}$ ) followed by pigeonpea+korra (Table 1). The reason for higher radiation use efficiency might be that capturing of light and efficient conversion of it into growth of harvested organs of the component crops (Fukaia and Trenbath, 1993)

### Rainwater use efficiency

Rain water use efficiency has significantly differed with sole crop and intercrops during the experiment. Among the sole crops, pigeonpea showed significantly higher rain water use efficiency

( $4.74 \text{ kg ha mm}^{-1}$ ) followed by korra. Among the intercrops, pigeonpea+blackgram showed significantly higher rain water use efficiency ( $8.10 \text{ kg ha mm}^{-1}$ ) followed by pigeonpea+korra (Table 1).

### CONCLUSION

Sole crop of pigeonpea and pigeonpea and blackgram (intercrop at 1:5 ratio) utilised higher radiation and rain water use efficiency and attained higher grain yield under rainfed conditions.

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## MICROWAVE EXTRACTION OF DYE FROM MADHUMALTI FLOWERS (*Combretum indicum*)

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### ABSTRACT

A new dye source Madhumalti flowers (*Combretum indicum*) a vine with red flower clusters which is locally available was selected for study. Dye extraction was carried out using Microwave radiation in order to reduce the time and energy consumption which is major drawback in conventional method of natural dyes. Dye extraction from Madhumalti flowers was carried out in various mediums (aqueous and acidic) in the different radiations of time 75 sec, 90 sec, 105 sec, 120 sec. The results revealed that extraction of natural source when compared to aqueous media, acidic media had lower absorption values for all percentages of dye and all four time periods of extraction. This indicates that aqueous extraction is a better method for extraction of dye from *Combretum indicum* flower.

### INTRODUCTION

India has a rich plant biodiversity due to which our country is ranked 11<sup>th</sup> among the biggest biodiversity countries in the world. It has approximately 4,90,000 plant species and is a treasure-house of diverse natural products (Neha Grover *et al.*, 2011). One such product from nature is the dye. The scenario changed rapidly due to the introduction of synthetic dyes which had great colour gamut and easy reproducibility. Production and usage of synthetic dyes has reached its peak that the sizable amounts of wastage and unfixed dye lead to the disturbance of eco-balance of nature besides being hazardous to human and aquatic life. Due to this, attention was paid to natural dyes once again and improvements in extraction and application methods have led to the development of a whole spectrum of colors. New sources and new methods of extraction and application is the need of the hour to meet the ever-growing demand of the consumers. With an urge to maintain environment and human life safe, and also to reduce water and energy consumption in dyeing, researchers worldwide are investigating the efficacy of different techniques for

extraction and analysis of natural dyes from new sources.

These new technologies include ultrasound, plasma, sonication and microwave techniques. Microwaves are electromagnetic waves with wavelengths ranging from 1 mm to 1 m, or frequencies between 300 MHz and 300 GHz (Naveen, 2013). Microwave system is found to decrease the reaction cycle, energy consumption along with increased dye efficiency. It is understood that the reaction time and energy input are supposed to be mostly reduced in the reactions that are run for a long time at high temperatures under conventional conditions. The microwave energy heats the water, and as heating of water occurs uniformly throughout the fiber, there is greater evenness of dye penetration.

New plant sources are examined for their gamut of colors they yield with different mordants. One such new source is Madhumalti flowers (*Combretum indicum*) also known as the Chinese honeysuckle or Rangoon creeper, a vine that can reach a height from 2 m to 8 m. Flowers are slender tubes of 1.5 inches to 3 inches long and have five prominent wings, which are initially white in color,

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which change to pink, purplish red, then bright red over a 3 days period. Review of literature showed that dye has not been extracted from this flower and, so, Madhumalti flowers were selected for the study.



Fig.1. New floral source Madhumalti (*Combretum indicum*)



Fig.2. Selection of dye source

## MATERIAL AND METHODS

The study was conducted during the year 2017-2018 to microwave extraction of dye from Madhumalti flowers. Madhumalti flowers were collected and dried under shade. Dry material was stored for further use. For about 100 g of fresh flower weight, there was a dry yield of 24 g.

The technique of microwave assisted extraction process was performed in experimental microwave oven (Samsung CV104ED). Dye source of 1g to 10 g dye was weighed and added to distilled water or water acidified with acetic acid. Water is used in the

ratio of 1:20 for standardization of both the dye extraction time and dye percentage. The effect of time on dye extraction was standardized at different time intervals from 30 seconds to 2 minutes (30s, 45s, 60 s, 75 s, 90 s, 105 s, and 120s) and are shown in Fig. 3, Fig. 4 and Fig. 5 at high power (900W). After the dye extract has cooled down to room temperature the solution was strained using Whatman filter paper No. 1. Later dye (1 to 10%) from extracted solution was used to measure optical density using a Premier Colorscan dual beam spectrophotometer SS 5100H.



Fig.3. Aqueous medium of Extraction

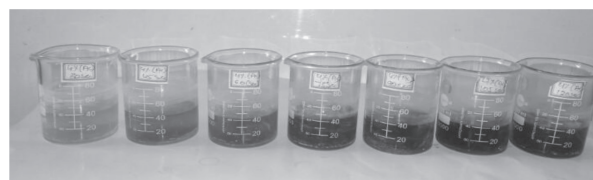


Fig. 4. Acidic medium of extraction

### a. Aqueous extraction

In this method water was used as the medium for extraction of dye. Raw material of different weights (1g to 10 g) was boiled in 100 ml of distilled water and the dye was extracted.

### b. Acidic extraction

The dye extraction was done in acidic medium. The solution was made acidic by the addition of 1 %of acetic acid in 100 ml of water. Dye material was added and boiled for required time (75 s to 120 s).

## RESULTS AND DISCUSSION

Extraction time was optimized by using dry flower material in microwave oven with a liquor ratio of 1:20 at different extraction times ranging from 30

seconds to 2 minutes with an increment of 15 s. Preliminary experimental trials indicated that dye extracted below 75 s using microwave oven yielded very pale colour on the fabric when dyed. So dye extraction from 75 seconds to 2 minutes with an incremental value of 15 s was followed. Along with the time of extraction, dye concentration was also optimized. Dye concentration was optimized using

varying amounts of dye from 1 to 10 g/l. Results of extraction time and dye concentration optimization are presented in Table 1 and Table 2 and using both aqueous and acidic extraction methods. Dye extraction time was optimized following the absorbency values (ABS) and the extract was evaluated using premier Colorscan dual beam spectrophotometer SS 5100H.

**Table 1. Optimization of dye extraction time for aqueous medium**

Dye percentage (%)	Dye Extraction time (seconds)			
	75 s	90 s	105 s	120 s
1	0.186	0.178	0.173	0.188
2	0.188	0.183	0.185	0.191
3	0.219	0.355	0.233	0.251
4	0.188	0.328	0.222	0.282
5	0.239	0.276	0.295	0.271
6	0.223	0.241	0.237	0.303
7	0.256	0.276	0.297	0.283
8	0.265	0.297	0.336	0.327
9	0.292	0.357	0.382	0.307
10	0.334	0.358	0.378	0.412

The ABS values were taken at maximum wavelength of 420 nm as indicated in the output of the spectrophotometer. There was a continuous increase in the ABS values when the dye concentration increased. Higher ABS values were observed at dye concentrations of 8% to 10 % indicating that higher dye concentration has yielded good amount of colour extract. The highest value of absorbency was obtained for 10 %dye concentration at 120 s of extraction in microwave oven and the second highest was at 9 % and 105 seconds of extraction. At 1% and 2 % dye concentration, there was no proper colour extraction in aqueous medium. At 75 s extraction time, ABS values continuously

increased from 1% to 10%. At 90 seconds of extraction and 3 % dye concentration, obtained ABS value was almost equivalent to that of 9 % and 10 %dye concentration at the same time of extraction. The lowest value of ABS was obtained at 1% dye concentration and 105 seconds of extraction. At 10 %dye concentration of aqueous extraction, highest ABS values were obtained when dye was extracted at 75 s, 90 s and 120 s except 105 s of extraction time (Fig.6). These variations observed in ABS values may be due to one of the disadvantages of natural dye where colour yield depends on many factors such as the time of collection of raw material, the stage of raw material, soil conditions and other factors.

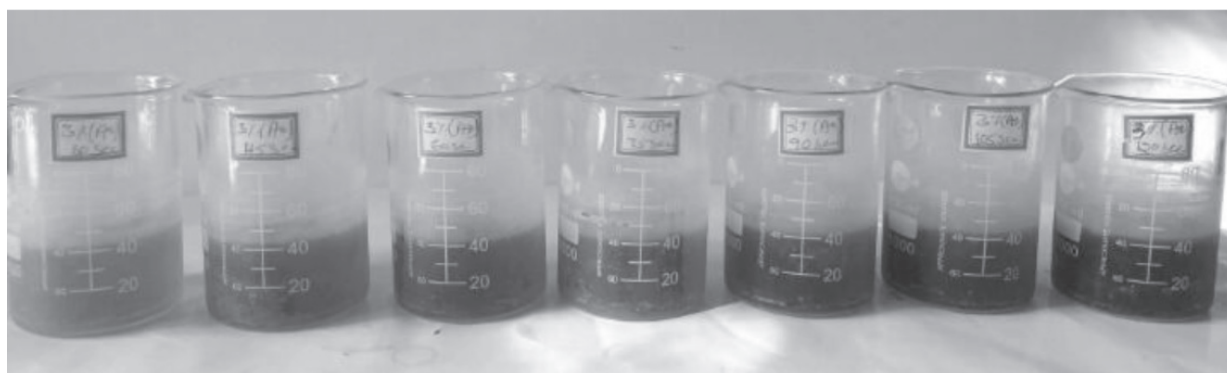
**Table 2. Optimization of dye extraction time for acidic medium**

Dye percentage (%)	Dye Extraction time (seconds)			
	75 s	90 s	105 s	120 s
1	0.125	0.126	0.135	0.129
2	0.138	0.166	0.158	0.148
3	0.161	0.149	0.168	0.156
4	0.139	0.174	0.162	0.197
5	0.158	0.174	0.191	0.234
6	0.249	0.229	0.208	0.312
7	0.242	0.230	0.214	0.234
8	0.197	0.231	0.263	0.230
9	0.259	0.250	0.248	0.265
10	0.225	0.227	0.257	0.246

The ABS values of dye extracted in acid medium for 4 different time periods of extraction are presented in Table 2. ABS value of 0.2 and above were observed in the extract from 5 % of dye concentration. The highest value was obtained at 6 % and 120 seconds of extraction while the second highest value was at the same extraction time but at 9 % dye concentration. The results indicate that 6 % dye concentration is better than 9 % dye in extraction of colour from Madhumalti flowers. Highest absorbance values were obtained at 9% dye concentration when extracted using microwave oven

at 75 seconds and 90 seconds, however, at 105 seconds of extraction time, the highest value was obtained at 8% dye concentration and at 120 seconds of extraction, the highest ABS values were yielded at 6 % and 9%. This indicates that time of extraction is more prominent when dye was extracted in acidic media.

When compared to aqueous media, acidic media had lower absorption values for all percentages of dye and all four time periods of extraction. This indicates that aqueous extraction is a better method for extraction of dye from *Combretum indicum* flower.

**Fig. 5. Optimization of dye extraction time at 9 % dye concentration in aqueous medium of extraction**

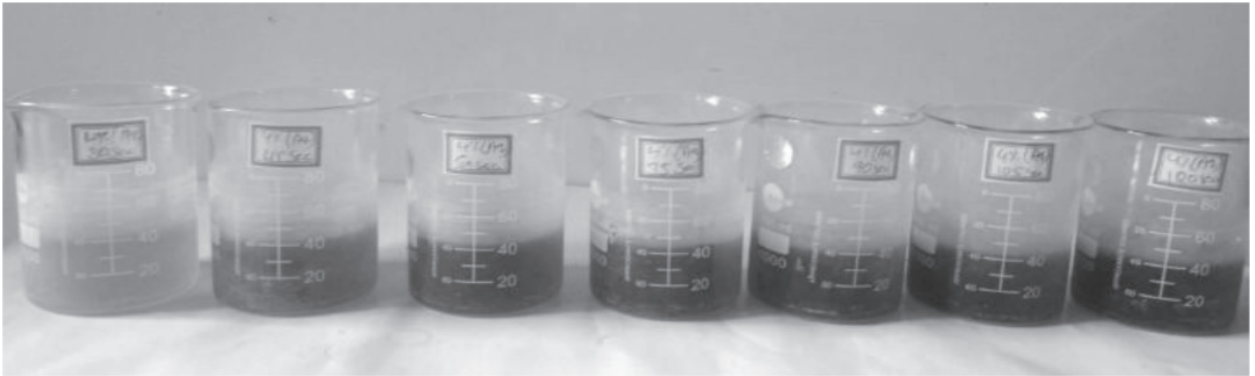


Fig. 6. Optimization of dye extraction time at 10 % dye concentration in aqueous medium of extraction

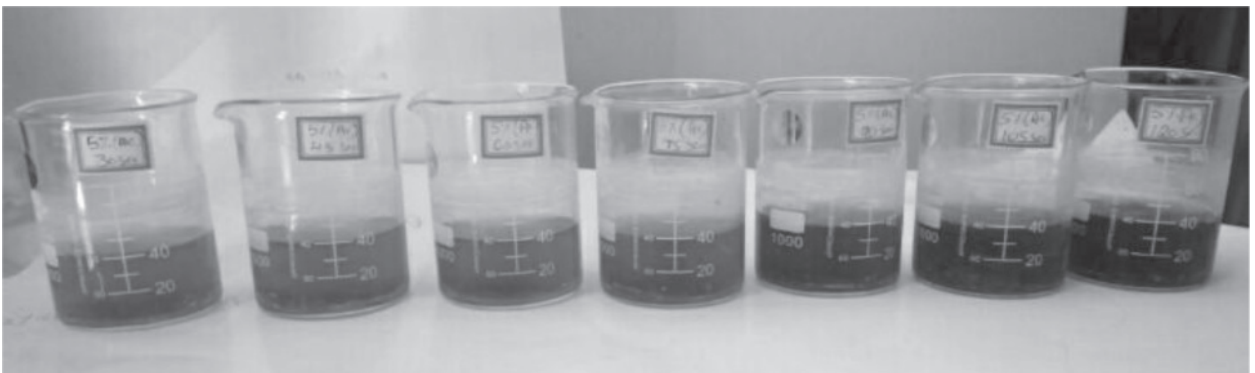


Fig. 7. Optimization of dye extraction time at 6 % dye concentration in acidic medium of extraction

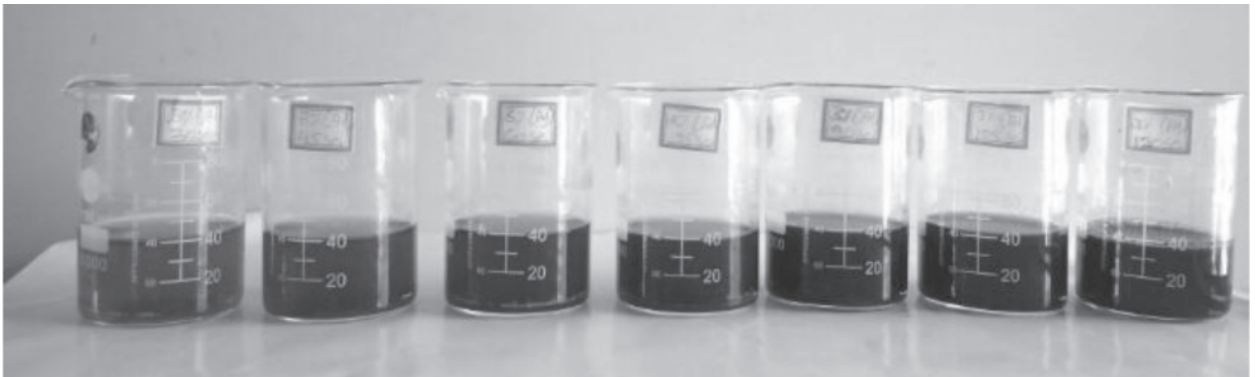


Fig. 8. Optimization of dye extraction time at 9% dye concentration in acidic medium of extraction

## CONCLUSION

Dye extraction from Madhumalti flowers was carried out in various mediums (aqueous and acidic) in the different radiations of time 75 seconds, 90 seconds, 105 seconds, 120 seconds. When

compared to aqueous media, acidic media had lower absorption values for all percentages of dye and all four time periods of extraction. This indicates that aqueous extraction is a better method for extraction of dye from *Combretum indicum* flower.

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## PERSISTENT ETHNOMEDICAL PRACTICES OF TRIBALS IN HUMAN HEALTH MANAGEMENT

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### ABSTRACT

Persistent ethno medical practices of tribals in Vizianagaram district of Andhra Pradesh were studied during March, 2018 to May, 2018. The paper provides data on 60 medicinal plants used by tribal communities of Vizianagaram district for curing various ailments in human health management, along with their local names, part used, mode of utilization and weighted mean score. The practices were studied and rationale was tested with the help of five experts from Ayush department. Ethno medical practices along with weighted mean score were presented and documented in the paper. The study revealed that the tribals have good knowledge of useful medicinal plants to treat wide spectrum of human ailments. Documented ethno medical practices will be useful in promoting eco-friendly health care system among both conventional and contemporary population including drug industries in view of their positive features and medicinal properties. There is an urgent need to preserve medicinal plants and traditional knowledge of tribals which helps in developing natural plant drugs for different ailments.

### INTRODUCTION

India is bestowed with medicinal plants that play an important role in maintaining the health and vitality of human beings since ancient time. They cure several diseases, without causing side effects and toxicity. This traditional knowledge system help to reduce the three main hurdles namely time, money and toxicity in drug development (Vishnuvardhan *et al.*, 2018).

The term ethno-medicine is used to mean the traditional health care methods which are based on indigenous cultural beliefs and practices and are not derived from the conceptual framework of modern medicine (Bhuyan, 2015). Persistent ethno medical practice is defined as the traditional medical practice which is continuing to exist or occur over a prolonged period not less than 20 years.

Tribal communities are considered to be the best forest dwellers living in harmony with their nature. According to Census of India (2011), the tribal population of India is 104.3 millions, constituting 8.6% of the total population. In the tribal society, the use

of ethno medical practices is well known since early days. Tribals use different plant species in treatment of various diseases using various parts of the plants.

Few studies are available on tribal health care such as on Kolams belonging to Adilabad district, Telangana state (Rao *et al.*, 2012), Chakma community of Tripura state (Guha and Chakma, 2015), Gond & Halba tribe of Chhattisgarh, India (Soni *et al.*, 2013).

Knowledge of medicinal plants is, however, rapidly decreasing due to rapid urbanization, reduction in number of traditional local healers, dependence of man on modern health care systems and lack of interest of the younger generations to carry on the tradition. Hence, there is a need to document ethno medical practices of tribal communities. Keeping these in view, the investigation was conducted on ethno medical practices in human health management. The practices were collected and documented for further use and preservation.

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## MATERIAL AND METHODS

Exploratory research design was adopted for this study. A large chunk of tribal population in the state is mainly concentrated in the six scheduled districts *viz.*, Srikakulam, Vizianagaram, Visakhapatnam, West Godavari, East Godavari and Kurnool (Radhika, 2016). Hence, Vizianagaram district of Andhra Pradesh was purposively selected for the study as it is the hub of tribals. Out of 8 tribal mandals of the district, two tribal dense mandals *viz.*, Gummalakshnipuram and Kurrupam were selected purposively for collection and documentation of the practices. One hundred and twenty (120) tribal respondents with minimum age of 40 years, who can provide age-old information, were selected purposively for the study. Data was collected through personal interview from the tribal respondents during March, 2018 to May, 2018. The collected practices were sent to the five experts of Ayush department for rationality purpose. The identified experts helped for testing the rationality of the collected ethnomedical practices on five point continuum "strongly agree", "agree", "undecided", "disagree" and "strongly disagree". The response of 'strongly agreed' and 'agreed' ethnomedical practices by the experts were considered as valid ethno medical practices. Based on the rationale given by the experts the weighted mean scores were calculated for the collected practices and were documented.

## RESULT AND DISCUSSION

Most of the tribal respondents were engaged in agriculture. With the passage of time, they have developed a great deal of knowledge on the use of plants and plant products in curing various ailments/diseases. They have a deep belief in the native folklore medicine for remedies and over generations have matured in the medicinal use of these types of plants. Acquired knowledge on native properties of plants against various diseases was transmitted from

one generation to another only verbally. Due to the onslaught of technology and modernization, the traditional knowledge is vanishing rapidly day by day. Hence, in this context the study is considered to bring out the information from the tribal people and document the rationalised ethno medical practices.

Plants used medicinally with their scientific names, family names, local names, part used and mode of utilization along with weighted mean score were listed. The ailments included cuts and wounds, diarrhoea, vomitings, dysentery, skin diseases, burns & boils, fever, headache, cough, cold, dental problems, snakebite, menstrual problems, gastric and stomach disorders, etc. Different parts of plants like leaves, roots, rhizome, fruits, seeds, etc. are being used for different purposes.

The data on the preferred ethno medical practices for the treatment of various human ailments were collected and analysed. The list and utilization of these have been presented in four tables and were given below. A total of 60 ethno medical practices were collected on human health management. The study also indicated that the tribal area was rich in medicinal plants useful to treat a wide spectrum of human ailments. The tribal people have knowledge of plants from utilitarian point of view. It was also observed that tribals have successful art of curing diseases in several localities of the district.

The findings of the study would be helpful for health development system to take necessary steps for encouraging the rich wealth of bio-resources and utilization of the ethno medicinal plants in suitable form for health care of the humans. It also helps in developing a documentary publication for promoting traditional health practices which are judged and accepted by the experts of the relevant areas. The documentary of the age old practices also serves the purposes such as conservation and preservation of the tribal traditional health heritage for further transmission to future generation.

Table 1. List of medicinal plants in which 'leaves' are used as a remedy for the treatment of various diseases

S. No	Scientific name of the plant along with its family name	Common name	Part used	Mode of utilization	Weighted mean score
1.	<i>Trianthema portulacastrum</i> L.(Aizoceae)	<i>Ambati kura</i>	Leaves	The leaves are used for treating inflammation and ascetics (accumulation of fluid in stomach, indigestion)	5.00
2.	<i>Diospyros melanoxylon</i> .Roxb (Ebenaceae)	<i>Beedi aaku</i>	Leaves	Decoction of the leaf acts as a laxative and used in constipation	5.00
3.	<i>Ocimum sanctum</i> Linn(Labiatae)	<i>Tulsi</i>	Leaves	Decoction of leaves mixed with sugar is given as a remedy for cough	5.00
4.	<i>Argemone mexicana</i> L.(Papaveraceae)	<i>Ballu rakasi</i>	Leaves	Leaf juice is applied on cut wounds, blisters and burns. Latex is used in ophthalmic infection	5.00
5.	<i>Bacopa monnieri</i> (L.)Penn. (Scrophulariaceae)	<i>Sambrani aaku</i>	Leaves	Leaf juice is given to infants for bronchitis. The plant is considered as a good blood purifier	4.67
6.	<i>Oroxylum indicum</i> (L) Benth exkurz (Bignoniaceae)	<i>Pampini</i>	Leaves	Paste of leaves is gently massaged over joints regularly to get relief in arthritis	4.67
7.	<i>Centella asiatica</i> (L) Urban (Apiaceae)	<i>Saraswathi aaku</i>	Leaves	Leaf juice with cow ghee is taken to improve memory power in children	4.67
8.	<i>Euphorbia hirta</i> Linn (Euphorbiaceae)	<i>Cukkamokka, pachabottlu</i>	Leaves	Two teaspoons of leaf extract is mixed with sugar and taken thrice a day for 3days to cure dysentery	4.67
9.	<i>Mentha arvensis</i> Linn (Labiatae)	<i>Pudina</i>	Leaves	Leaves infusion is taken for rheumatic pains and indigestion	4.33
10.	<i>Psidium guajava</i> Linn (Myrtaceae)	<i>Jaama</i>	Leaves	Leaves are used to cure dental problems	4.33
11.	<i>Alstonia scholaris</i> (L.)R. Br (Apocynaceae)	<i>Edakula pala</i>	Leaves	After warming the tender leaves on the flame, they are made into a paste and applied on the boils to suppress swellings	4.33

Contd...

Table 1 Contd...

S. No	Scientific name of the plant along with its family name	Common name	Part used	Mode of utilization	Weighted mean score
12.	<i>Pergularia daemia</i> (Forsk) (Asclepiadaceae)	<i>Dhusta-puthega</i>	Leaves	1. Leaf extract mixed with honey is used as de-worming agent in infants 2. Paste of leaves is used as cough expectorant	4.33
13.	<i>Mentha arvensis</i> Linn(Labiatae)	<i>Pudina</i>	Leaves	Leaves infusion is taken for rheumatic pains and indigestion	4.33
14.	<i>Cuscuta reflex</i> Roxb(Cuscutaceae)	<i>Bangaru theega</i>	Leaves	The leaves are soaked in warm water and that water is used to wash sloughing and purulent sores	4.33
15.	<i>Sesbania grandiflora</i> (Linn) Poir (Fabaceae)	<i>Avisa</i>	Leaves	Decoction made from the leaves if taken daily before going to sleep, controls constipation	4.33
16.	<i>Terminalia tomentosa</i> W&A. (Combretaceae)	<i>Inna Maddi</i>	Leaves	Leaves paste is given to cure vomiting and loose motions	4.33
17.	<i>Amaranthus viridis</i> L.(Amaranthaceae)	<i>Chilakathotakura</i>	Leaves	The leaves are slightly heated and ground into a paste and applied to relieve pain due to insect bites	4.00
18.	<i>Alternanthera sessilis</i> (L) (Amaranthaceae)	<i>Ponnaganitkura</i>	Leaves	Luke worm leaves are applied for the eyes to treat eye irritation	4.00
19.	<i>Ipomea aquatica</i> Forssk (Convolvulaceae)	<i>Thutikura</i>	Leaves	The leaves are dried and pulverised. This powder is mixed with oil and applied externally to cure bleeding rectal haemorrhoids	3.67
20.	<i>Atylosia Scarabaeoides</i> (L) Benth (Fabaceae)	<i>Pedda adavi kandi</i>	Leaves	Leaf decoction, taken four times a day controls loose stools in dysentery	3.67
21.	<i>Lannea coromandelica</i> (Anacardiaceae)	<i>Gumpena</i>	Leaves	The leaves are boiled and mixed with gingelly oil and applied over tender tendons to relieve swelling	3.67
22.	<i>Tribulus terrestris</i> L.(Zygophyllaceae)	<i>Chinnapalleru</i>	Leaves	Leaf decoction is used as a tonic to get relief from painful menstruation	3.33

Table 2. List of medicinal plants in which 'roots' are used as a remedy for the treatment of various diseases

S. No	Scientific name of the plant along with its family name	Common name	Part used	Mode of utilization	Weighted mean score
1.	<i>Amaranthus spinosus</i> L. (Amaranthaceae)	Mullathotakura	Roots	The root is washed and boiled to prepare a decoction which is sieved and consumed early in the morning with empty stomach to relieve unusual abdominal pain and also pain during menstruation	4.67
2.	<i>Asparagus racemosus</i> Wild (Liliaceae)	Chandamama gadalu	Roots	Root paste mixed with sugar candy is given for curing Leucorrhoea	4.33
3.	<i>Aristolacia indica</i> (Aristolocaceae)	Eshwari	Roots	1. Paste made out of roots and extract of leaves are used to treat snake bite2. Roots are used to treat fever and skin infections	4.33
4.	<i>Lawsonia inermis</i> L. (Lythraceae)	Gorintaaku	Roots	Root paste mixed with sugar candy is given for jaundice	4.33
5.	<i>Smilax zeylanica</i> L. (Liliaceae)	Kondatham-mara, Sithapa	Roots	Root paste is prescribed in anaemia	4.00
6.	<i>Ficus glomerata</i> Roxb. (Moraceae)	Attimanu, Paidi, Brahmameddi	Roots	Sap from root is given as remedy for stomach disorder.	4.00
7.	<i>Ranwolfia serpentine</i> (L.) Benthexkurz(Apocynaceae)	Sarpagandhaa	Roots	Decoction provides relief from headache.	4.00
8.	<i>Alangium salviolium</i> (L.F) (Alangiaceae)	Vooduga	Roots	A paste made from the bark of the root taken with lemon juice before two hours of breakfast and supper, helps to treat asthma.	3.67
9.	<i>Argyreia nervosa</i> (Burm.f.)Boj (Convolvulaceae)	Samudrapala	Roots	Matured roots are powdered and mixed with a cup of milk. This is taken twice daily for forty days to reduce the pain and burning sensation in the bone joints.	3.67
10.	<i>Ceiba pentandra</i> (L) Gaertn (Bombacaceae)	Tella booruga	Roots	Root powder along with Lemon juice if taken twice a day for forty days, helps to controls diabetes	3.33
11.	<i>Withania Somnifera</i> (L). Dunal in DC(Solanaceae)	Ashwagandha	Roots	The powder made from the roots of this plant is mixed with hot milk to reduce the constipation problemThe leaves of the plants are taken to lose weight	2.67

Table 3. List of medicinal plants in which 'fruit' is used as a remedy for the treatment of various diseases

S. No	Scientific Name of the plant along with its family name	Common name	Part used	Mode of utilization	Weighted mean score
1.	<i>Benincasa hispida</i> (Thund) (Cucurbitaceae)	<i>Budidha gummadi</i>	Fruit	The juice of the fruit is used in insanity and nervous disorders	5.00
2.	<i>Dillenia indica</i> L.(Dilleniaceae)	<i>Uvva chettu</i>	Fruit	Fruit is used as laxative and relieves abdominal pain	5.00
3.	<i>Diospyros malabarica</i> (Desr) Kostel.(Ebenaceae)	<i>Nitta tumiki</i>	Fruit	Fruit made into a paste is taken twice a day to control blood dysentery	5.00
4.	<i>Semecarpus anacardium</i> L.f. (Anacardiaceae)	<i>Bhallatamu</i>	Fruit	Fruit is an important ingredient in some native medicines for dyspepsia, piles and skin diseases	5.00
5.	<i>Solanum xanthocarpum</i> scharad and wendl.(Solanaceae)	<i>Pinnamulaka, Nelamulaka</i>	Fruit	The fruit boiled in ghee is given for cough and toothache	5.00
6.	<i>Syzgium cumini</i> (Linn.) Skeel. (Myrtaceae)	<i>Neredu</i>	Fruit	Vinegar prepared from fruit is useful in dysentery. Seeds are used for treating diarrhoea and constipation	5.00
7.	<i>Embllica officinalis</i> Gaerth (Euphorbiaceae)	<i>Useeri kaya</i>	Fruit	Fruit is eaten to cure cough. Fruit juice is used to reduce eye inflammation. Boiled fruit is used externally for skin diseases	4.67
8.	<i>Aegle mameelos</i> Correa. Ex.Roxb (Rutaceae)	<i>Maaredu</i>	Fruit	Fruit pulp is aromatic, cooling, laxative and digestive	4.67
9.	<i>Albizia lebbek</i> Benth (Mimosaceae)	<i>Dirisena chettu</i>	Fruit	Decoction of bark, leaves and fruit is given in case of anaemia and curing itching	3.33

Table 4. List of medicinal plants in which various parts of the plant are used as a remedy for the treatment of various disease

S. No	Scientific name of the plant along with its family name	Common name	Part used	Mode of utilization	Weighted mean score
1.	<i>Brassica nigra</i> (L) Koch (Brassicaceae)	Nalla aavalu	Seed	The seed is used as a stimulant, and as an antidote in snake-bite	5.00
2.	<i>Celastrus paniculata willd</i> (Celastraceae)	Maneer thegga	Seeds	Seed oil is useful in epilepsy and skin diseases	5.00
3.	<i>Allium cepa</i> Linn(Liliaceae)	Uulli	Tuber	Onion juice is used to stop bleeding from nose Onion is used to improve the beauty	4.67
4.	<i>Boswellia serrata</i> Roxb (Bursaceae)	Parangi, sambrani chettu	Tree	Gum is used in rheumatism, nervous and skin diseases	4.67
5.	<i>Adina cordifolia</i> Hook (Rubiaceae)	Maani pasupu	Bark	Bark paste is given to kill worms	4.67
6.	<i>Careya arborea</i> Roxb.(Myrtaceae)	Khumbhi	Bark	Bark paste is used for indigestion and flatulence	4.33
7.	<i>Trigonella foenum-graecum</i> L.(Fabaceae)	Menthulu	Seeds	Paste made from the seeds is taken twice a day regularly for forty days to control diabetes.	4.33
8.	<i>Costus speciosus</i> (Koenig) smith (Costaceae)	Bookachiika	Rhizome	It helps to avoid worm infection in the body. This plant is taken continuously for 15 days during menstruation, to avoid pregnancy.	4.00
9.	<i>Achyranthus aspersa</i> L.vra (Amaranthaceae)	Uttareni	Seeds	1) The seeds are ground into a paste and applied over poisonous insect bitten area. Thus, it works as an antidote2) Roots are dried (100 g) and powdered. If a pinch of the powder is consumed daily, it helps to cure night blindness	4.00
10.	<i>Shorea robusta</i> Gaertn.f. (Dipterocarpaceae)	Guggilamu	Resin	Small quantity of powdered resin is taken with hot milk to relieve chest pain and stomach ache	3.67

Contd...

Table 4 Contd...

S. No	Scientific Name of the plant along with its family name	Common name	Part used	Mode of utilization	Weighted mean score
11.	<i>Aerva lanata</i> (L.) Juss (Amaranthaceae)	<i>Pindikura</i>	Whole plant	The whole plant is used as a de-worming agent in children	3.67
12.	<i>Acacia caesia</i> (L.) Wild. (Mimosaceae)	<i>Korintha</i>	Shrub	Flowers are used to correct the irregular menstrual cycle in women	3.67
13.	<i>Justicia adhatoda</i> (Acanthaceae)	<i>Adda sarum</i>	Flowers	Concentrated decoction is made by flowers. To the decoction if a spoonful of honey is added and given for seven days, it helps to get relief from cough and oral bleeding	3.67
14.	<i>Anacardium occidentale</i> L. (Anacardiaceae)	<i>Jeedi mamidi</i>	Stem	Application of pulverized bark of the stem with an adequate panama pinnate seed oil cures sores and ulcers	3.67
15.	<i>Celosia argentea</i> (Amaranthaceae)	<i>Gunugu</i>	Seeds	The seeds are made into a paste and applied orally to mouth ulcers for quick healing	3.67
16.	<i>Celosia cristata</i> L. (Amaranthaceae)	<i>Kodejuttu thotakura</i>	Flowers	Five grams of dried flower powder is mixed with water in which rice were washed. If taken as a dose for five times in a day helps to control diarrhoea	3.40
17.	<i>Annona Sqamosa</i> Linn(Annonaceae)	<i>Seetaphalam</i>	Seeds	Paste made from <i>seetaphalam</i> seeds is applied over the scalp to terminate dandruff and lice	3.33
18.	<i>Puerariatuberosa</i> (Roxd.ex.wild)(Fabaceae)	<i>Nelagummadi</i>	Rhizome	The paste made out of pulverized rhizome is heated and applied on the painful joints for relief from arthritis	3.00

## CONCLUSION

Vizianagaram district is rich with wild herbal medicinal plants. Through ages, tribals of that area were utilizing these plant resources to cure various common ailments. As there is an increasing demand for medicinal plants, the study suggests that there is an urgent need for conservation and cultivation of medicinal plants in a sustainable way. Documentation of the medical practices will preserve the rich herbal treasure of the tribal population in human health management. It was also observed that some medicinal plants and practices in tribal areas are rapidly eroding. The study addressed the issue and documented 60 ethno medical practices followed by tribals of Vizianagaram district for curing common ailments and diseases.

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## STUDY ON PARTICIPATION OF MEMBERS IN COMMODITY BASED ASSOCIATIONS IN KARNATAKA

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### ABSTRACT

The study was conducted in Bangalore (rural) district to know the level of participation of the members in Commodity Based Associations (CBAs) established by University of Agricultural Sciences, Bangalore. The results revealed that nearly half (43.60 per cent) of the CBA members were having medium level of participation in the formation stage of the CBAs. Participation of the members in production oriented activities of CBAs was good and it is reported that 41.60 per cent of CBA members were having high level of participation. Nearly half of the CBA members (45.60 %) were having high level of participation in the training related activities of CBAs. More than one-third (40.80%) of the CBA members were found to have high level of participation in the marketing oriented activities of CBAs. Overall, 40.40 % of the CBA members were having high level of participation in major activities of CBAs.

### INTRODUCTION

Rapid agricultural growth continues to be the key to poverty alleviation and overall economic development of India. Agriculture accounts for about one-sixth of the GDP and is the source of livelihood for nearly two-thirds of the population. The agriculture sector in India has been successful in keeping pace with the rising food demand of the growing population. Food grains production has increased more than five folds since the early 1950s from 51 million tons to over 275.68 million tons in 2017-18 (ICAR, 2018).

Public research and extension played a major role in increasing the food production in the country. However, extension system faced important challenges in the areas of relevance, accountability and sustainability. It is expected that future agriculture growth would largely accrue from improvements in productivity of diversified farming systems with regional specialization and sustainable management of natural resources, especially land and water. Effective linkages of production system, agro-processing and other value added activities

would play an increasingly important role in the diversification of agriculture.

The Department of Biotechnology (DBT), Government of India (GoI) has launched the project namely Rural Bio-Resource Complex (RBRC) on a pilot basis across the country at five selected centers and one such centre is located in the University of Agricultural Sciences, Bangalore. The Rural Bio-Resource Complex (RBRC) project was conceptualized during 2005 in the University of Agricultural Sciences, Bangalore by a team of interdisciplinary scientists with a view to revisit the unsustainable agricultural system. The RBRC project contemplates to enhance the income and standard of living of people by way of addressing end to end issues.

As a part of strategy, Rural Bio-Resource Complex project actively promoted Commodity Based Associations (CBAs) as means of strengthening backward and forward linkages with a special focus to ensure profitable sale of farm produce with least overhead charges. These

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associations are built around group of farmers/farm women, which are proven to be reliable vehicles for participatory and sustainable rural development.

The investigation specially focused to study the participation of members in the Commodity Based Associations (CBAs) and to find out the relationship between the selected characteristics of CBA members with their participation.

## **MATERIAL AND METHODS**

The study was conducted in Doddaballapur taluk of Bangalore (rural) district in Karnataka state during the year 2014-15. The Tubagerehobli was purposefully selected where ten Commodity Based Associations were established by Rural Bio-Resource Complex Project. Ten Commodity Based Associations positioned appropriately in different project sites were selected for the study. Two hundred and fifty (250) members from 10 CBAs were selected based on proportionate random sampling.

*Ex-post facto* research design was adopted for the study. Sixteen independent variables were considered for the study *viz.*, age, education, farming experience, family dependency ratio and land holding, social participation, cosmopolitaness, management orientation, deferred gratification, achievement motivation and innovativeness, mass media participation, participation in training programme, extension participation, farmer- scientist contact , extension contact and extension participation.

## **RESULTS AND DISCUSSION**

### **Participation of members in the activities of Commodity Based Associations**

The participation of members in the Commodity Based Associations was measured in four stages. The stages include (1) Formation of CBAs, (2) Production oriented activities of CBAs, (3) Training oriented activities of CBAs and (4) Marketing oriented activities of CBAs. Finally, overall participation was measured using the combined score of all the four stages.

### **Participation of members in the formation stage of CBAs**

At the formation stage of CBAs, 43.60 per cent of the CBA members were having medium level of participation. Whereas, 29.60 per cent of them were having high level of participation and the remaining 26.80 per cent of the CBA members were having low level of participation (Table 1).

The formation of Commodity Based Associations involves various activities which includes, awareness programme about the CBA formation, information sharing including networking with other farmers, collection of bench mark information, selection of office bearers, registration, meetings formation of CBA, management of 'revolving' fund for group activities, establishing contacts with government and other agencies, working towards welfare of the CBA members, profit utilization for development of CBA, social welfare activities of CBA and acquisition of land for CBA.

The possible reasons for having medium level of participation in the formation activities could be the realization of the benefits from the membership. The supporting organization DBT-RBRC has conducted good number of meetings for conveying the rationale behind the formation of the CBAs. The credibility of information regarding the advantages of Commodity Based Associations might have had direct effect on the farmers' participation. The educational activities conducted by RBRC in the area before the establishment of the Commodity Based Associations might have enabled the CBA members to acquire knowledge regarding the advantages of the CBAs. These are the reason for CBA members to take active part in the formation of CBAs. Suchith Kumar (2011) conducted study on the jackfruit growers association in Bangalore rural district and reported that majority of the members exhibited medium level of participation (42.5%) followed by high (28.33) and low (26.17%) participation.

### **Participation of members in the production oriented activities of CBAs**

The findings indicate that more than one-third of the CBA members (41.60%) were having high level of participation in the production oriented activities of CBAs. Whereas, 31.20% and 27.20% of the CBA members having medium and low levels of participation in the activities of CBAs, respectively (Table 1). The CBAs were established with an objective of reducing the production cost. DBT-RBRC conducted various programmes for the benefit of CBA members on crop production. After the withdrawal of the project from the area, the associations were made self-sustainable through linkages with line department, *Krishi Vigyan Kendras* and University of Agricultural Sciences, Bangalore.

The associations are linked with the technology production and transfer system. The members have received benefits from both the systems on various activities such as field trials on production practices, identification of technical and product opportunities, popularizing the crops in the jurisdiction, implementing the cropping programme, seedling distribution camps, training programme for rural youth, consolidation of land holdings for large scale farming, apiary, vermi-composting, nursery raising, fish rearing, ragi malt preparation, sheep rearing and mulberry cultivation and labour sharing for production and marketing purpose. Due to realization of the various benefits as members of CBAs, most of the members were having high level of participation in the production oriented activities of the CBAs.

The results are in conformity with the findings of Afolami *et al.* (2012) who studied effect of group formation on rice farming in Ekiti and Ogun states of south-west Nigeria and reported that a higher proportion of rice farmers participation in cooperative projects helped them to access better markets (84.00%), credit (72.00%), farm inputs (67.00%) and processing mills (61.00%). The study on farmers'

participation in community development organizations in Obubra area of Nigeria by Augustine and Paul (2012) reported that 33.3% of the members had high participation and 36.7% had low participation in social organizations.

### **Participation of members in the training oriented activities of CBAs**

The results reveal that 45.60 per cent of the CBA members were having high level of participation in the training oriented activities of CBAs, while 29.60% and 24.80% of them had medium and low levels of participation, respectively (Table 1). Organization of the training programmes to enhance the agricultural production and minimize the cost of production happened to be the prime objective of the CBAs. The parent organization has provided CBA members training on various aspects of the crop production. Good number of trainings programmes were organized by RBRC on crop production, animal husbandry, silk worm rearing, processing and value addition, marketing and personality development of CBA members. The CBA members had actively participated in the training programmes. However, more number (45.60%) of CBA members were having high level of participation in training programmes.

### **Participation of members in the marketing oriented activities of CBAs**

The results indicate that 40.80% of the CBA members were having high level of participation in the marketing oriented activities of CBAs followed by 34.80% and 24.4% of the CBA members having medium and low levels of participation, respectively (Table 1). The Commodity Based Associations intends to reduce the marketing cost and enhance the farm income of the members. The CBAs had carried out marketing activities for the benefit of the members, which includes bulk selling, direct marketing, pooling of commodities, developing market networks and assessments, providing common transport facility for the produce, promoting

participation of CBAs members in *melas*, price fixing, negotiation, processing and grading of commodities.

Most of the CBA members were small and marginal farmers and had marketing problems when produce was of limited quantity. Besides, transportation and handling of small quantity of produce to the market has resulted in increased marketing cost which was not viable for most of the members previously. In order to make agriculture a viable option, the CBAs took up various activities in marketing of the produce produced by the CBA members. Hence, most of the members had high level of participation in the marketing activities of the CBAs.

### **Overall participation of members in the activities of Commodity Based Associations**

The findings revealed that 40.40 per cent of CBA members were having high level of participation, whereas 32.00 per cent and 27.60 per cent of them were having low and medium levels of participation in the activities of Commodity Based Associations, respectively (Table 1). The reasons for more number (40.40%) of CBA members having higher level of participation in the activities of CBAs is due to their good participation in production, training and marketing oriented activities of CBAs.

The findings are in line with the study conducted by Afolami *et al.* (2012) and Augustine and Paul (2012) who indicated that higher level of participation of the members in the organizations is due to the benefit that likely to derive from the participation such as market opportunity, credit availability and the income.

### **Relationship between participation of members in the activities of commodity based association and their personal, socio-psychological and communication characteristics**

Correlation test was employed to test the relationship between the characteristics of members and their participation in CBA activities. Variables

such as management orientation, innovativeness, participation in training programmes, farm scientist contact, extension contact and extension participation had highly significant relationship at 1% level with participation of members in the activities of commodity based associations (Table 2). Further, variables such as education, achievement motivation, cosmopolitanism and mass media participation had significant relationship at 5% level with the participation of members in the activities of CBAs. The variables such as age, family dependency ratio, land holding, farming experience, deferred gratification and social participation were having non-significant relationship with participation of members in the activities of commodity based associations.

The management orientation of the members provided them with an opportunity to have greater understanding in the activities of CBA which has lead them to actively participate in the CBAs. An individual who want to excel with his innovativeness will participate more in CBA activities for increasing annual income and social status. Hence, participation of members in CBA activities found to have significant relationship. The members might have expected that change in lifestyle is possibly accomplished by participating in CBA activities.

Exposure to training programmes provided an opportunity to the members to understand the importance and need of Commodity Based Associations. Hence, it can be inferred that higher the exposure to training, greater was the participation in CBA activities. The scientific staff's regular contact with members of CBA might have influenced the CBA members to actively participate and derive benefits. The exposure of members to extension personnel of *Krishi Vignana Kendra* has motivated members to actively take part in CBA activities. The exposure of members to different extension activities such as field visits, demonstration, group discussions, field days, etc. have motivated them to take active part in the CBA activities. The reasons could be exposure

**Table1. Participation of members in the activities of Commodity Based Associations****(n=250)**

S.No.	Stages	Category	CBA Members	
			F	%
1	Formation of CBAs	Low	67	26.80
		Medium	109	43.60
		High	74	29.60
2	Production oriented activities of CBAs	Low	68	27.20
		Medium	78	31.20
		High	104	41.60
3	Training oriented activities of CBAs	Low	62	24.80
		Medium	74	29.60
		High	114	45.60
4	Marketing oriented activities of CBAs	Low	61	24.40
		Medium	87	34.80
		High	102	40.80
5	Overall participation in CBAs	Low	80	32.00
		Medium	69	27.60
		High	101	40.40

to need based training programmes provided the CBA members. Hence, it can be inferred that more is the exposure to training, higher was the participation in CBA activities. The scientist contact was found to have significant association with the participation in CBA activities. The scientists who have regular contact with members of CBA might have influenced the CBA members for active participation and derive benefits from the commodity based associations.

#### **Extent of contribution of personal, socio-psychological and communication characteristics of members to their participation in Commodity Based Associations activities**

All the 16 independent variables contributed to the tune of 69.99 per cent to the participation of

members in the activities of commodity based associations.  $R^2$  value of 0.6999 with significant 'F' value (12.61) revealed the significance and 1 % level of regression equation in explaining the variation (Table 3).

It can be further observed from the Table 3 that variables such as education, management orientation, achievement motivation and innovativeness were found to be significant at 5% level in explaining the variation. Whereas, variables such as cosmopolitaness, participation in training programme, farm scientist contact, extension contact and extension participation were significant at one per cent level in explaining the variation.

**Table 2. Relationship between participation of members in the activities of CBA and their personal, socio-psychological and communication characteristics**

(n=250)

S. No.	Characteristics	Correlation coefficient (r)
<b>I. Personal variables</b>		
1	Age	0.058 NS
2	Education	0.208*
3	Family dependence ratio	0.071 NS
4	Land holding	0.096 NS
5	Farming experience	0.121 NS
<b>II. Socio-psychological variables</b>		
6	Management orientation	0.374**
7	Achievement motivation	0.259*
8	Innovativeness	0.203**
9	Cosmopoliteness	0.216*
10	Deferred gratification	0.187 NS
11	Social participation	0.142 NS
<b>III. Communication variables</b>		
12	Mass media participation	0.236*
13	Participation in training programme	0.377**
14	Farm scientist contact	0.584**
15	Extension contact	0.597**
16	Extension participation	0.557**

NS: Non-Significant; \*: Significant at 5% level; \*\*: Significant at 1% level

It can be inferred that the nine variables have significantly contributed to the variation in the participation of the members in the CBA activities. The activities of the CBAs in enhancing the knowledge skill and attitude of farmers has helped them to have high influence on their participation as the members.

The variables which are found significant such as cosmopoliteness, participation in training programme, farm scientist contact, extension

contact and extension participation are those which have direct impact on the attitude of individuals. These characteristics plays an important role in decision making which influences the individual to participate or not to participate.

**Reasons for success of Commodity Based Associations as perceived by its members**

The results reveal that technical guidance from the supporting organization (Rank-I) followed

**Table3. Extent of contribution of personal, socio-psychological and communication characteristics of members to their participation in CBA activities**

(n=250)

S. No.	Characteristics	Regression coefficient (b)	Standard Error of Regression coefficient (SE <sub>b</sub> )	't' value
<b>I. Personal variables</b>				
1	Age	0.011	0.080	0.91NS
2	Education	0.796	0.029	0.23*
3	Family dependence ratio	0.013	0.011	1.15NS
4	Land holding	0.280	0.290	0.96NS
5	Farming experience	0.106	0.079	1.34NS
<b>II. Socio-psychological variables</b>				
6	Management orientation	0.441	0.367	2.11*
7	Achievement motivation	0.261	0.130	2.00*
8	Innovativeness	0.861	0.357	2.41*
9	Cosmopolitaness	0.468	0.583	3.66**
10	Deferred gratification	0.059	0.167	0.35 NS
11	Social participation	0.307	0.211	1.45 NS
<b>III. Communication variables</b>				
12	Mass media participation	1.288	0.352	0.80 NS
13	Participation in training programme	0.248	0.911	3.66**
14	Farm scientist contact	1.766	0.491	3.59**
15	Extension contact	0.535	0.143	3.74**
16	Extension participation	0.994	0.214	4.65**

R<sup>2</sup> = 0.6999, F =12.61\*\*; NS: Non-Significant;

\*: Significant at 5% level; \*\*: Significant at 1% level

**Table 4. Reasons for success of Commodity Based Associations as perceived by its members**

(n=250)

S. No.	Reasons*	CBA Members		Ranking
		Frequency	Percentage (%)	
1.	Technical guidance from supporting organization	199	79.6	I
2.	Economic benefits for CBA members	198	79.2	II
3.	Self employment opportunity provided by CBA	190	76.0	III
4.	Lower marketing cost due to pooled marketing	160	64.0	IV
5.	Reduction in production cost due to labour sharing	134	53.6	V
6.	High reserve funds, increased assets, total sales and profits of the CBA	131	52.4	VI
7.	Appropriate leadership in the CBA	125	50.0	VII
8.	Recognition in the society for the CBA members	113	45.2	VIII
9.	Interdependence among group members	104	41.6	IX
10.	Minimization of the gap between social perception and CBA action	100	40.0	X
11.	Small group size of the commodity based association	99	39.6	XI
12.	Gender composition of the group members	23	9.2	XII

\* Multiple Responses

by economic benefits for CBA members (Rank-II), self employment opportunity provided by CBA (Rank-III), lower marketing cost due to pooled marketing (Rank-IV), reduction in production cost due to labour sharing (Rank-V), high reserve funds, increased assets and total sales and profits of the CBA (Rank-VI) were the main reasons for the success of the CBAs as perceived by its members (Table 4).

The CBAs were established to improve the standard of living of the farmers. The associations are carrying wide range of responsibilities such as input procurement and distribution, technology management, barter exchange of labour, value addition, processing and tapping export opportunities. CBAs has ensured the sustenance of

the technologies promoted under the RBRC project even after the withdrawal of the project with effective functional linkages particularly with local *Krishni Vignana Kendra*.

The functional linkages established with KVK, Agricultural University and Line Departments such as agriculture, horticulture, fisheries, animal husbandry has provided members an opportunity to get technical guidance from the extensional personnel. Therefore, most of the members of CBAs opined that availability of technical knowledge is the major reason for the success of the CBAs.

Economic benefits for CBA members is the another reason for the success of the CBAs and is ranked II. The CBAs provided the individual with an

opportunity to take various income generating activities such as floriculture, fish culture, ragi malt preparation and direct marketing. All these activities significantly contribute to the monetary benefits.

The other important reason for the success of CBAs is self employment opportunity provided by CBA and it is ranked III. Due to participation in the CBAs, there is significant change in the life of the members such as crop diversification; direct marketing without involvement of middlemen in the market chain, involvement in processing and value addition has generated employment for the benefit of the members. Therefore, majority of the members felt the CBAs have provided self employment opportunity as one of the reasons for the success of CBAs.

The other reason for the success of the commodity based associations is lower marketing cost due to pooled marketing which is ranked IV. The CBAs with an intention of reducing the overhead charges introduced bulk marketing approach by pooling the produces produced by the members. Due to pooled marketing the cost involved in transportation and marketing is shared among the members, thereby, the marketing cost has significantly reduced.

Reduction in production cost due to labour sharing is another reason for the success of the commodity based associations which is ranked V. The CBAs promoted bulk purchasing and labour sharing for the benefit of the members. Due to cost sharing among the members the production cost has substantially decreased, hence, member opined that the lower marketing cost and reduction in production cost due to participation in the Commodity Based Associations are the reasons for success.

The other reason for the success is high reserve funds, increased assets and total sales and profits of the CBA which is ranked VI. The CBA was provided with seed money of Rs. 1,00,000/-. Apart

from the seed money, the CBAs have also collected a membership amount of Rs.100 for each CBA member. Hence, the financial assets of the CBAs have substantially increased and members felt that the increased assets are the reason for the success of the associations.

The other reasons stated by the CBA members for the success of CBAs are, appropriate leadership in the commodity based association (Rank-VII), recognition in the society for the CBA members (Rank-VIII), interdependence among group members (IX), minimization of the gap between social perception and CBA action (Rank-X), small group size of the commodity based association (Rank-XI), gender composition of the group members (Rank-XII) and availability of loan facility for the members (Rank-XIII).

## **CONCLUSION**

The results indicated that the most of the members had active and high level of participation in the CBAs. The higher level of participation in formation of CBAs, production, training and marketing oriented activities of CBAs is due to the economic and social benefits that the members realize from the CBAs membership. With the available public extension workers, it is not possible to reach all the farmers. Promoting group approach is the need of the hour especially for India where the ratio of extension workers to farmers is very wide (1:1000). The results also indicated that the timely technical guidance from the supporting organizations was found to be one of the major reasons for the success of the CBAs. Hence, establishment of CBAs with adequate functional linkages and technical guidance can lead to the success of group approach. Hence, development departments and policy makers should link the initiatives and programmes of development departments with CBAs for better convergence, synergy and participation of beneficiaries in the programmes.

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## CORRECTNESS AND USABILITY ANALYSIS OF MEDIUM RANGE WEATHER FORECAST FOR KRISHNA ZONE OF SOUTH COASTAL ANDHRA PRADESH

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Indian agriculture is monsoon dependent as it is a tropical monsoon country. The rainfall received during the monsoon period is the governing factor in determination of crops to be raised, extent of area under each crop, cropping pattern, which in turn influences the production and productivity of the agriculture commodities in India. In addition, rainfall is the source of filling of all major reservoirs in the country. Inter seasonal and intra seasonal variation of weather factors also have greater influences on almost all agricultural operations right from sowing to harvest, transport, storage and marketing of agricultural produce. The farmers of the country are facing many extreme weather events such as irregular distribution, high intensity rains, unseasonal rains, floods and drought having significant influence on change in the crops, cropping pattern, yield, pest, disease scenario and marketability of the agricultural produce. Hence, to overcome the difficulty, Indian Meteorological Department (IMD), through Regional Met Centre (RMC), Hyderabad is providing early forecast regarding all the weather parameters including the rainfall. Such forecasts are disseminated to farmers, and early forecasts of weather events have the potential to help farmers to take the appropriate remedial measures that could avoid or reduce economic loss due to unpredictable weather abnormalities such as untimely rain, variation in the intensity, uneven distribution of rains, splash rains etc. These losses could be minimized by providing timely and accurate forecast by considering the local weather observations and making adjustment in local

crop management through the short and medium range weather forecasts to the farmers. This improves the economy by taking strategic decision in accordance with forecast and actual crop condition on time. Gadgil (1987) stated the agriculturally relevant forecast is not only useful for efficient management of farm inputs but also leads to precise impact assessment. Devi and Rao (2008) reported that agromet advisory services based on medium range weather forecasts have been identified as a micro level management strategy for mitigating the impact of climatic variations on agricultural production and income. In view of the above, study was conducted to verify the correctness and usability of the medium range weather forecast issued to the farmers of agro climatic zone of Krishna of the south coastal Andhra Pradesh.

Medium range weather forecast was given by National Centre for Medium Range Weather Forecast (NCMRWF), IMD, New Delhi through Regional Met Centre, Hyderabad on various weather parameters viz., amount of rainfall, cloud cover, maximum and minimum temperature, wind speed and direction for the period from 2015-2016 to 2017-18 for Krishna agro climatic zone. Forecasted rainfall data was compared with observed values collected from the different meteorological observatories located in Krishna (115), Guntur (134), and Prakasam (191) in south coast of Andhra Pradesh. Data pertaining rainfall was analyzed for correctness and usability for forecast issued for the region under "*Gramin Krishi Mausam Sewa (GKMS)*

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**Table 1. Correctness and usability analysis of forecasted rainfall for Krishna District**

Season	2015-16			2016-17			2017-18		
	Correct	Usable	Unusable	Correct	Usable	Unusable	Correct	Usable	Un usable
Monsoon (Jun-Sept)	78.54	16.29	5.76	69.43	15.73	14.80	74.29	15.72	9.96
Post monsoon (Oct-Nov)	93.33	1.65	5.00	91.93	4.89	1.61	59.07	9.68	31.20
Winter (Dec-Feb)	97.85	1.07	1.07	97.85	1.07	1.07	94.62	0.00	0.00
Summer (Marc-May)	100.00	0.00	0.00	97.85	1.07	1.07	96.70	2.22	1.07
<b>Yearly</b>	<b>92.43</b>	4.75	2.96	<b>89.26</b>	5.69	4.64	<b>81.17</b>	6.90	10.56

**Table 2. Correctness and usability analysis of forecasted rainfall for Guntur District**

Season	2015-16			2016-17			2017-18		
	Correct	Usable	Unusable	Correct	Usable	Unusable	Correct	Usable	Un usable
Monsoon (Jun-Sept)	85.98	9.85	3.25	66.97	14.80	18.16	75.37	13.01	11.61
Post monsoon (Oct-Nov)	93.39	4.90	1.65	98.39	1.61	0.00	67.36	18.01	14.62
Winter (Dec-Feb)	98.92	1.07	0.00	97.85	0.00	2.13	95.70	3.22	1.07
Summer (Marc-May)	97.83	1.07	1.07	98.92	0.00	1.07	100.0	0.00	0.00
<b>Yearly</b>	<b>94.03</b>	4.22	1.49	<b>90.53</b>	4.10	5.34	<b>84.61</b>	8.56	6.83

scheme" by using the error structure method developed by Rana *et al.* (2013).

The location specific medium range weather forecast received for Krishna zone from Regional Met Center IMD, Hyderabad on every Tuesday and Friday was verified by calculating the error structure season wise viz., *Kharif* (June-September), *Post monsoon* (October-November), winter (December-February) and summer (March-May). Initially, the error structure was used to categorize the forecast given as correct, usable and unusable based on the percent

deviation in the forecast values as compared to actual observed values as per the guidelines of National Centre for Medium Range Weather Forecasting (NCMRWF). The correct and usable cases were summed up. The combined values indicate the percent usability of the forecasted to the actual observed number of events. The method adopted is furnished below:

**Error structure for Rainfall:** Correct  $\pm$  10mm, Usable  $\pm$  20mm, Unusable  $>$   $\pm$  20mm

**Table 3. Correctness and usability analysis of forecasted rainfall for Prakasam District**

Season	2015-16			2016-17			2017-18		
	Correct	Usable	Unusable	Correct	Usable	Unusable	Correct	Usable	Unusable
Monsoon (Jun-Sept)	85.85	9.97	4.16	58.94	13.92	19.0525	72.76	14.72	12.47
Post monsoon (Oct-Nov)	85.21	13.1	1.65	96.71	3.275	0	57.47	18.00	24.51
Winter (Dec-Feb)	97.84	2.14	0	97.84	2.15	0	94.62	2.15	3.22
Summer (Marc-May)	100.00	0	0	98.92	1.07	0	96.77	2.15	1.07
<b>Yearly</b>	<b>92.23</b>	6.31	1.46	<b>88.11</b>	5.11	4.76	<b>80.41</b>	9.26	10.32

Assessing the correctness of given forecast for Krishna zone was verified with error structure method developed by Rana *et al.* (2013). In this context, the amount of forecasted rainfall Vs. actual observed amount of rainfall pertaining to the Krishna zone which comprises of Krishna, Guntur and Prakasam districts of south coastal Andhra Pradesh was verified season-wise for its correctness and usability and results were furnished in Table 1, Table 2 and Table 3, respectively.

The district wise correctness of the forecasted rainfall of Krishna district pertaining to monsoon, post monsoon, winter and summer during 2015-16, 2016-17 and 2017-18 and the annual correctness of forecast was 92.43, 89.26 and 81.17, respectively (Table 1). In case of Guntur district, the annual correctness of forecast was 94.43, 90.53 and 84.61 (Table 2). In case of Prakasam district, it was indicated that the annual correctness of forecast was 92.23, 88.11 and 80.41, respectively (Table 3). These results are in accordance with the results of Das *et al.* (2018) who reported that in Malkangiri district of Odisha the seasonal forecast for rainfall were 94.12%, 7.45%, 77.14% and 100% correct during pre-monsoon, monsoon, post monsoon and winter seasons, respectively. The overall results indicated

that the correctness of forecast was higher during the summer compared to monsoon, post monsoon and winter and it might be due to the sudden changes in the dynamics of earth and ocean.

#### ACKNOWLEDGEMENT

The daily rainfall forecast for all three districts of Krishna agro-climatic zone of Costal Andhra Pradesh are issued weekly twice (Tuesday and Wednesday) by the Regional Met Centre, IMD, Hyderabad. The values of normal and actual rainfall are taken from APSDPS, Govt. of A.P. Authors acknowledge both for their contribution.

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## INSTRUCTIONS TO AUTHORS

The Journal of Research ANGRAU is published quarterly by Acharya N.G. Ranga Agricultural University. Papers submitted will be peer reviewed. On the basis of referee's comments, author(s) will be asked by the editor to revise the paper. **All authors must be members.** Papers are accepted on the understanding that the work described is original and has not been published elsewhere and that the authors have obtained necessary authorization for publication of the material submitted. A certificate signed by all authors indicating the originality of research work should be enclosed along with the manuscript. **Articles should contain data not older than five years. The period shall be calculated from the following January or July after the completion of the field experiment in *Kharif* (rainy) and *Rabi* (winter) seasons, respectively.**

**Subject Matter:** Articles on all aspects of agriculture, horticulture, forestry, agricultural engineering, home sciences and social sciences with research and developments on basic and applied aspects of crop improvement, crop management, crop protection, farm implements, agro-technologies, rural development, extension activities and other suitable topics.

**Typed script:** It should be in clear concise English, typewritten in double space using Times New Roman Font (size 12) on one side of A4 size paper with at least 2 cm margin. Full research paper should not exceed 10 typed pages including tables and figures and should contain abstract, introduction, material and methods, results and discussion, conclusion and references. All articles should be submitted at E-mail i.d.: **angraujournal@gmail.com. *Hard copy is not required.***

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**TITLE:** This should be informative but concise. While typing the title of the paper/note all the letters must be in upper case. The title must be typed just before the commencement of abstract. No abbreviations should be used in the title.

Names should be in capitals prefixed with initials and separated by commas. For more than two authors the names should be followed by 'and' in small letters before the end of last name. Full address of the place of research in small letters should be typed below the names. E-mail i.d of the author may be given as foot note.

**ABSTRACT:** A brief informative abstract should follow on the first page of the manuscript. It should clearly bring out the scope of the work and its salient features. It should be single paragraph of not more than 200 words.

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#### **Books**

AOAC. 1990. Official methods of analysis. Association of official analytical chemists. 15<sup>th</sup> Edition. Washington DC. USA. pp. 256.

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### **Seminars / Symposia / Workshops**

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### **Website**

Cotton Corporation of India. 2017. Area, production and productivity of cotton in India. Retrieved from website ([www.cotcorp.gov.in/statistics.aspx](http://www.cotcorp.gov.in/statistics.aspx)) on 21.9.2017.

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