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Performance of Cabbage Genotypes as Influenced by Bio-Fertilizers and Nitrogen Doses

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ABSTRACT Golden Acre was found earliest to harvest, whereas Pusa Mukta excelled in respect of net weight of head and yield attributes over others out of the three cabbage cultivars (Pride of India, Golden Acre and Pusa Mukta) tested in the present studies. The combined use of nitrogen and *Azospirillum* proved to be the most effective treatment for the enhancement of net weight and yield of cabbage heads.

Keywords: Cabbage, Nitrogen, Azospirillum and Azotobacter.

The indiscriminate use of chemical fertilizers has resulted in change in soil structure, imbalance in soil microorganism and organic matter and has affected the water holding capacity of the soil, which is creating several health and environmental problems [1]. Under these circumstances, use of biofertilizers is a valuable option to reduce the doses of chemical fertilizers. So the present study was conducted to know the performance of cabbage cultivars fertilized with doses of nitrogen and biofertilizers.

MATERIALS AND METHODS

The present experiment was conducted at Vegetable Research Farm of Dr. YSPUHF, Solan during winter season, on three open pollinated varieties of cabbage viz. Pride of India (V_1), Golden Acre (V_2) and Pusa Mukta (V_3) at a spacing of 45cm x 30cm. Five doses of nitrogen i.e. N_0, N_{15}, N_{30}, N_{45} and N_{60}kg/ha were applied through calcium ammonium nitrate (CAN). Two bio agents (Azotobacter-B_1 and Azospirillum-B_2) were used for seed, root and field treatment to improve the nitrogen use efficiency [2]. The experiment was laid out in split plot design with 4 replications. Seeds of cabbage cultivars were treated with biofertilizers culture and dried in shade for 30 minutes before sowing. At second stage roots of seedlings were dipped in slurry for 30 minutes before transplanting. The slurry was prepared by mixing Azotobacter and Azospirillum culture separately @ 1kg /ha in 5 liters of water. Finally, biofertilizers were applied as soil applications @ 5kg/ha mixed in 50kg FYM and applied uniformly before transplanting in the field. The crop was raised in loamy-clay well-drained soil having pH 6.8. The fertility status of the soil was 319.0kg, 48.80kg, and 289.2kg of available N, P and K respectively per hectare basis.

RESULTS AND DISCUSSION

Marketable maturity was significantly influenced by cultivars, nitrogen levels, biofertilizers and interaction of nitrogen and biofertilizers. while rest of the interactions were not found to differ significantly (Table la & b). The maximum days were taken to marketable maturity to Pusa Mukta (112.30 days) when Azospirillum was applied, while the minimum days were recorded in variety Golden Acre (86.73 days) in the absence of biofertilizers, which may be because of direct contribution of biofertilizers towards the enhanced uptake of nitrogen or by the applied nitrogen itself. Similarly,

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Table 1. Effect of nitrogen levels (kg/ha) and biofertilizers on days to marketable maturity in cabbage cultivars

(a)

Cultivars	Nitrogen Levels					Biofertilizers			Mean
	N_0	N_{15}	N_{30}	N_{45}	N_{60}	No biofertilizers(B_0)	Azotobacter (B_1)	Azospirillum (B_2)	
Pride of India (V_1)	95.67	101.30	102.30	105.00	98.67	99.00	101.00	101.80	100.60
Golden Acre (V_2)	82.89	86.33	89.00	92.00	88.56	86.73	87.63	88.93	87.67
Pusa Mukta (V_3)	106.00	111.20	113.00	114.30	111.30	109.80	111.40	112.30	111.20
Mean	94.85	99.63	101.40	103.80	99.52	98.51	100.00	101.00	

(b)

Cultivars	Treatments Nitrogen Levels														
	N_0			N_{15}			N_{30}			N_{45}			N_{60}		
	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2
Pride of India (V_1)	94.00	96.00	97.00	99.00	102.00	103.00	100.00	103.00	104.00	102.00	106.00	107.00	100.00	98.00	98.00
Golden Acre (V_2)	80.00	84.00	84.67	85.00	87.00	87.00	88.00	89.00	90.00	90.00	92.00	94.00	90.67	86.00	89.00
Pusa Mukta (V_3)	104.00	106.00	108.00	109.00	112.00	112.70	111.00	114.00	114.00	112.00	115.00	116.00	113.00	110.00	111.00
Mean (NXB)	92.67	95.33	96.57	97.67	100.30	100.90	99.67	102.00	102.70	101.30	104.30	105.70	101.20	98.00	99.33

CD (0.05) V-1.32 N-1.71 B-0.98 NXB-2.20

Table 2. Effect of nitrogen levels (kg/ha) and biofertilizers on number of non-wrapper leaves in cabbage cultivars

(a)

Cultivars	Nitrogen Levels					Biofertilizers			Mean
	N_0	N_{15}	N_{30}	N_{45}	N_{60}	No biofertilizers(B_0)	Azotobacter (B_1)	Azospirillum (B_2)	
Pride of India (V_1)	11.46	12.29	12.29	12.07	11.91	11.47	12.61	11.91	12.00
Golden Acre (V_2)	8.53	9.08	9.27	11.37	9.96	9.22	9.58	10.31	9.64
Pusa Mukta (V_3)	10.32	9.87	10.04	10.38	10.86	10.02	10.54	13.32	10.29
Mean	10.10	10.41	10.53	11.27	10.91	10.24	10.91	10.79	

(b)

Cultivars	Treatments Nitrogen Levels														
	N_0			N_{15}			N_{30}			N_{45}			N_{60}		
	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2
Pride of India (V_1)	11.30	12.13	10.93	11.87	12.10	12.90	11.37	13.37	12.07	11.57	13.13	11.50	11.27	12.30	12.17
Golden Acre (V_2)	8.17	8.23	9.20	8.40	9.07	9.77	8.37	9.37	10.07	11.20	11.37	11.53	9.97	9.83	10.07
Pusa Mukta (V_3)	10.00	10.27	10.70	10.17	9.93	9.50	9.43	10.33	10.37	10.30	10.00	10.83	10.20	12.17	10.20
Mean (NXB)	9.82	10.21	10.28	10.14	10.37	10.72	9.72	11.02	10.83	11.02	11.50	11.29	10.48	11.43	10.81

CD (0.05) V-0.38 N-0.49 B-0.29 VXN-0.84 VXB-0.51 NXB-0.68 VXNXB-0.16

Table 3. Effect of nitrogen levels (kg/ha) and biofertilizers on heading percentage in cabbage cultivars

Cultivars	Nitrogen Levels					Biofertilizers			Mean
	N_0	N_{15}	N_{30}	N_{45}	N_{60}	No biofertilizers(B_0)	Azotobacter (B_1)	Azospirillum (B_2)	
Pride of India (V_1)	82.67 (9.12)	85.11 (9.25)	88.00 (9.41)	87.56 (9.38)	89.33 (9.48)	88.57 (9.28)	88.27 (9.42)	85.60 (9.27)	86.53 (9.33)
Golden Acre (V_2)	83.56 (9.17)	86.44 (9.32)	88.89 (9.45)	86.44 (9.32)	89.78 (9.50)	86.40 (9.32)	88.67 (9.44)	86.00 (9.30)	87.02 (9.35)
Pusa Mukta (V_3)	86.07 (9.33)	89.56 (9.489)	88.88 (9.45)	89.11 (9.47)	89.11 (9.46)	86.80 (9.34)	89.73 (9.50)	90.80 (9.55)	89.11 (9.46)
Mean	84.30 (9.21)	87.04 (9.35)	88.59 (9.43)	88.37 (9.42)	89.48 (9.48)	86.31 (9.31)	88.89 (9.45)	87.47 (9.37)	

(b)

Cultivars	Treatments Nitrogen Levels														
	N_0			N_{15}			N_{30}			N_{45}			N_{60}		
	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2
Pride of India (V_1)	78.67 (8.90)*	86.00 (9.30)	83.33 (9.156)	82.00 (9.08)	86.00 (9.30)	87.33 (9.37)	88.67 (9.44)	90.00 (9.91)	85.33 (9.26)	88.67 (9.44)	88.00 (9.41)	86.00 (9.30)	90.67 (9.55)	91.33 (9.58)	86.00 (9.30)
Golden Acre (V_2)	83.33 (9.16)	86.00 (9.30)	81.33 (9.05)	82.00 (9.08)	88.00 (9.41)	89.33 (9.47)	89.33 (9.48)	92.67 (9.65)	84.67 (9.23)	88.00 (9.41)	86.00 (9.30)	85.33 (9.26)	89.33 (9.48)	90.67 (9.54)	89.33 (9.47)
Pusa Mukta (V_3)	84.67 (9.23)	88.00 (9.40)	87.33 (9.37)	84.67 (9.23)	92.00 (9.62)	92.00 (9.61)	85.33 (9.26)	88.00 (9.40)	93.33 (9.69)	89.33 (9.48)	90.67 (9.55)	93.33 (9.69)	90.00 (9.51)	90.00 (9.51)	88.00 (9.40)
Mean (NXB)	82.22 (9.09)	86.67 (9.33)	84.00 (9.189)	82.89 (9.13)	88.67 (9.44)	89.56 (8.48)	87.78 (9.39)	90.22 (9.52)	87.78 (9.39)	88.67 (9.44)	88.22 (9.42)	88.22 (9.42)	90.00 (9.51)	90.67 (9.55)	87.78 (9.40)

CD (0.05) N-0.17 * figures in parenthesis are square root transformed values

Table 4. Effect of nitrogen levels (kg/ha) and biofertilizers on net weight of head in cabbage cultivars

(a)

Cultivars	Nitrogen Levels					Biofertilizers			Mean
	N_0	N_{15}	N_{30}	N_{45}	N_{60}	No biofertilizers(B_0)	Azotobacter (B_1)	Azospirillum (B_2)	
Pride of India (V_1)	326.67	473.33	510.57	550.53	636.70	469.32	506.68	499.56	499.56
Golden Acre (V_2)	377.10	490.57	546.10	590.53	701.67	513.26	532.34	577.98	541.19
Pusa Mukta (V_3)	441.10	615.53	777.77	845.53	896.23	659.06	723.32	763.32	715.23
Mean	381.62	526.48	611.48	662.20	744.87	547.21	587.45	621.33	

(b)

Cultivars	Treatments Nitrogen Levels														
	N_0			N_{15}			N_{30}			N_{45}			N_{60}		
	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2
Pride oflndia (V_1)	268.3	331.7	380.0	433.3	490.0	496.7	500.0	506.7	525.0	538.3	553.3	560.0	606.7	651.7	651.7
Golden Acre (V_2)	338.0	338.0	413.3	460.0	496.7	515.0	538.3	541.7	558.3	563.3	575.0	633.0	666.7	668.3	770.0
Pusa Mukta (V_3)	295.0	480.0	548.3	575.0	593.3	678.3	718.3	805.5	810.0	838.3	845.0	853.3	868.7	893.3	926.7
Mean (NXB)	300.4	397.2	447.2	489.4	526.7	563.3	585.5	617.8	631.1	646.6	657.8	682.8	714.0	737.8	782.8
CO (0.05)	V-61.15	N-78.95	VXN-136.68	NXB-80.54											

Table 5. Effect of nitrogen levels (kg/ha) and bio-fertilizers on total yield (q/ha) of head in cabbage cultivars

(a)

Cultivars	Nitrogen Levels					Biofertilizers			Mean
	N_0	N_{15}	N_{30}	N_{45}	N_{60}	No biofertilizers(B_0)	Azotobacter (B_1)	Azospirillum (B_2)	
Pride of India (V_1)	144.70	197.83	245.93	272.13	315.50	220.82	231.76	252.48	235.02
Golden Acre (V_2)	186.33	242.37	269.77	295.07	343.30	253.58	265.98	282.54	267.36
Pusa Mukta (V_3)	217.90	324.67	389.97	417.17	442.73	329.00	365.72	381.04	358.58
Mean	182.98	255.51	301.89	328.29	366.84	267.84	287.82	305.37	

(b)

Cultivars	Treatments Nitrogen Levels														
	N_0			N_{15}			N_{30}			N_{45}			N_{60}		
	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2	B_0	B_1	B_2
Pride of India (V_1)	132.6	138.9	162.6	163.8	187.7	242.0	242.1	245.4	250.3	265.9	273.9	276.6	299.7	312.9	330.9
Golden Acre (V_2)	167.6	187.7	204.2	227.3	245.4	254.4	265.9	267.6	275.8	278.3	289.0	317.9	329.3	340.2	360.4
Pusa Mukta (V_3)	145.7	237.1	270.9	284.0	335.1	354.9	372.1	397.7	400.1	414.1	417.4	421.5	429.1	441.3	457.8
Mean (NXB)	148.5	187.9	212.6	225.0	256.1	285.4	293.4	303.6	308.7	319.4	326.8	338.7	352.7	364.8	383.0

CD (0.05) V - 29.99 N - 38.73 VXN - 65.67 VXB - 28.33 NXB - 36.56 VXNXB - 63.34

Golden Acre took minimum number of days (82.89 days) without nitrogen, while the maximum numbers of days (114.3) were recorded in variety Pusa Mukta with 45kg N/ha. This resulted in the prolonged vegetative growth phase. Golden acre was also found to be earliest cultivar (100 days) out of 9 cultivars studied by Misra and Singh [3].

Although non-wrapper leaves is a genetic character but it was interestingly noted that application of Azotobacter tended to show the highest number of non wrapper leaves (12.61) in variety Pride of India which was followed by the Azospirillum (11.91) (Table 2a & b). The same cultivar also showed the highest number of leaves (13.37) when Azotobacter was applied in combination with 30kgN/ha. This may be because of better vegetative growth as a result of more availability of nitrogen applied exogenously or due to bacterial activity towards nitrogen fixation. Apart from nitrogen fixing ability, Azospirillum is known to produce growth-promoting substances, which favour better growth of plants [4]. They also suggested that Azotobacter is a chemohetrotroph organism of aerobic character having the capability of fixation of dinitrogen (N2) as non symbiont and has shown to increase growth of a variety of vegetables.

The heading percentage in all the three cultivars tested here was significantly influenced only by the application of nitrogen, while effects of rest of the treatment combinations were observed similar statistically (Table 3a &b). The heading percentage progressively increased with every additional dose of nitrogen applied resulting in maximum head formation (89.48%) at 60kg N/ha which was significantly higher over without nitrogen (84.30%). This may be attributed to early establishment of plant population and judicious uptake of nutrients from the soil.

The data given in Table 4 (a & b) reveal that the net weight of cabbage head was significantly affected by variety, nitrogen, and interaction of variety and nitrogen and nitrogen and biofertilizers; while biofertilizers, variety X biofertilizers failed to exert any significant influence on the net weight of head. The application of highest dose of nitrogen proved to be the most effective treatment for net weight of cabbage head applied alone (744.87g) or in combination with Azospirillum (782.8g). Among three cultivars tested in the present studies, Pusa Mukta excelled over other two cultivars in respect of net weight (715. 23g) of head. Almost similar trend was noticed in case of total yield (Table 5 a&b) of cabbage head and its highest value was recorded in Pusa Mukta (358.58q/ha). Misra and Singh [3] also noticed the similar variation in 9 cultivars of cabbage. In the interaction studies, the combination of 60kg N/ha and Azospirillum, tended to show the highest yield of Pusa Mukta cabbage head (457.8q/ha). Application of Azospirillum with 75% recommended dose of nitrogen gave maximum yield of cabbage cv. Pride of India in Satpura hills of Madhya Pradesh [5]. Singh and Dixit [4] suggested that Azospirillum, an associative symbiotic nitrogen fixing bacterium has higher nitrogen fixing potential. The probable justification for this increase may be that N element plays a major role in the synthesis of chlorophyll and amino acids, which constitute building block of protein.

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