Indian Journal of Agricultural Sciences **83** (7): 745–7, July 2013/Article

Productivity and profitability of vegetable pea (*Pisum sativum*) under sprinkler irrigation and PSB seed inoculation

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Received: 2 March 2011; Revised accepted: 1 April 2013

ABSTRACT

Field experiments were conducted during winter seasons of 2007-08 and 2008-09 at Norman E Borloug Crop Research Centre, Pantnagar on sandy loam soil to assess the impact of seed inoculation with phosphate solubilizing bacteria (PSB) and irrigation schedules with sprinklers on vegetable pea (*Pisum sativum* L.). Results revealed that yield attributes and green pod yield was not influenced significantly by PSB inoculation while irrigation schedules did. Irrigation scheduled at IW: CPE 1.0 through sprinklers produced at par green pod yield with flood irrigation at vegetative and flowering stages but recorded 19.2 and 30.9% higher green pod yield than 0.8 and 0.6 irrigation schedules. Similarly, values of yield components were also higher under this treatment. PSB inoculated treatment recorded 11.1% higher water-use efficiency than no inoculation. Among the irrigation schedules, maximum WUE was noticed with IW: CPE 0.6 treatment (97.0 kg/ha-cm) while lowest (51.3 kg/ha-cm) was observed with flood irrigation at vegetative and flowering stages. In terms of gross, net return and B: C ratio, IW: CPE 1.0 was superior to other treatments.

Key words: Green pod yield, IW: CPE, PSB, Vegetable pea

Vegetable pea (*Pisum sativum* L.) is a highly profitable cash crop grown during winter in sequence with transplanted rice in *Tarai* region of Uttarakhand over an area of 11 100 ha with annual green pod production of 72 500 mt (NHB 2008). It is sensitive both to excess and deficit moisture conditions. Either of the moisture stresses adversely affect the crop growth and productivity. Therefore, optimum soil moisture regime during course of crop growth is of paramount importance for higher crop and water productivity. Flood irrigation often leads to excess moisture however, sprinkler irrigation wherein controlled and precise amount of irrigation water can be applied has been found more suitable to this crop. Higher productivity of pea with sprinkler irrigation over flood method has been reported by De *et al*. (2007).

Apart from optimal moisture, supply of plant nutrients particularly phosphorus greatly influences the performance of legume crop but the difficulty in ensuring optimal phosphorus supply is that a larger portion of applied or available soil phosphorus is fixed in the soil. However, phosphate solubilizing bacteria (PSB) which plays an important role in mineralizing the soil P in available form may augment the phosphorus availability. Phosphate-solubilizing microbes transform the insoluble phosphorus to soluble forms by acidification, chelation, exchange reactions, and polymeric substances formation. The use of phosphate-solubilizing microbes in agronomic practices helps not only to offset the high cost of phosphatic fertilizers but also to mobilize insoluble phosphorus in the fertilizers and soils. Hence, application of such naturally occurring organisms possessing multiple growth-promoting activities hold greater promise for increasing the productivity of leguminous crops. Inoculation of lentil seed with phosphate-solubilizing bacteria (PSB) improved its seed and straw yield besides improving P use efficiency (Singh *et al*. 2005). Thus present study envisages to workout optimum irrigation schedule with sprinkler irrigation and impact of PSB on crop productivity and profitability in *Tarai* belt of Uttarakhand.

MATERIALS AND METHODS

Field experiments were conducted during *rabi* seasons of 2007-08 and 2008-09 at the Norman E. Borloug Crop Research Centre, GBPUA&T, Pantnagar. Soil of the experimental site was sandy loam in texture having pH 7.3, high organic carbon (1.01%), low available nitrogen (213 kg/ha), medium available phosphorus (27 kg P_2O_5 ha) and potassium (235 kg K_2O/ha) contents. Eight treatments consisting of seed inoculation @ 10 g/kg seed with PSB (*B. megaterium* var. *phosphaticum*) and no inoculation and four irrigation schedules (sprinkler irrigation at IW: CPE 0.6, 0.8,

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1.0 and flood irrigation at vegetative and flowering stages) were laid out in a Factorial Randomized Block Design with three replications. Vegetable pea var Arkel was sown in the second week of November at row spacing of 30 cm. The recommended dose of N: P_2O_5: K_2O (30:70:30) was applied at the time of sowing. In sprinkler and flood irrigation, 3.0 and 5.0 cm irrigation depth, respectively was applied. The moisture contents at field capacity and permanent wilting point were 22.0 and 7.5%, respectively. The rainfall received during the first and second year was 2.8 mm and 15.0 mm, respectively. Economics was worked out on the basis of prevailing market prices of produce and inputs.

RESULTS AND DISCUSSION

Growth and yield attributes

The differences in plant height due to both phosphorus solubilizing bacteria treatment and irrigation schedules were found to be significant (Table 1). Seed inoculation with PSB produced taller plants (34.0 cm) than uninoculated treatment (33.6 cm). Taller plants in PSB treatment might be due to release of plant growth promoting substances by phosphobacteria. These results were in conformity with the findings of Sharma *et al*. (2007).

Irrigation scheduled at IW/CPE ratio of 1.0 resulted in the plant height (35.7 cm) similar to irrigation at vegetative and flowering stages (35.5 cm) but produced significantly taller plants than IW/CPE 0.6 and 0.8 ratios. This could be attributed to increase in frequency of irrigation which affected higher uptake of water and nutrients ultimately leading to increase in plant height. This was in harmony with the findings of Gowri (2005).

Among yield attributes, the significant effect of PSB treatment was observed only for the number of pods/plant, whereas grains/pod, pod weight/plant and pod length were improved marginally with the PSB inoculation over no inoculation. PSB inoculation recorded significantly higher number of pods/plant (3.80) than untreated seeds (3.63). The higher values of yield attributes might be associated with increased availability of phosphorus due to PSB treatment which in turn played an important role in rapid cell-division and elongation in the merismatic regions, root development and proliferation and enhancing flowering, pod setting and seed formation. Dubey *et al*. (1999) have also reported higher values of yield attributes with PSB inoculation over no inoculation

All the yield attributes varied significantly with irrigation schedules except pod length. Irrigation scheduled at IW: CPE 1.0 produced 32.7, 19.9 and 19.2% higher number of pods/plant than irrigation scheduled at IW: CPE 0.6, 0.8 and vegetative and flowering stages, respectively. Irrigation scheduled at IW: CPE 1.0 also recorded maximum number of grains/pod and pod weight. This could be ascribed to the fact that under optimum soil moisture conditions, the translocation and storage of photosynthates from source to sink is more efficient. Thus, yield attributes increased with improved moisture supply attaining the highest values under IW: CPE 1.0 among all the irrigation schedules. Similar results were reported by Mavi *et al*. (1994).

Shelling percentage

PSB treatment did not influence shelling percentage significantly while, irrigation schedules did (Table 1). Crop irrigated at IW: CPE 1.0 being at par with IW: CPE 0.8 recorded significantly higher shelling percentage than other irrigation schedules, might be due to more number of grains/pod under this treatment.

Green pod yield

The variations in the green pod yield due to PSB inoculation were not significant, however, it produced 1.69 q/ha higher green pod yield than no inoculation. Irrigation scheduling had significant impact on green pod yield (Table 2). Sprinkler irrigation at IW: CPE at 1.0 ratio recorded the highest green pod yield (72.36 q/ha) however, it was at par with flood irrigation at vegetative and flowering stages

Table 1 Plant height and yield attributes of vegetable pea under different irrigation schedules and PSB seed inoculation

Treatment	Plant height (cm)	Pods/ plant	Grains/ pod	Pod weight/ plant (g)	Pod length (cm)	Shelling (%)
PSB treatment						
Un-inoculated	33.58	3.63	5.02	13.00	7.25	45.36
Inoculated	33.97	3.80	5.39	14.16	7.31	46.01
CD (P=0.05)	0.34	0.11	NS	NS	NS	NS
Irrigation schedule						
Sprinkler at IW:CPE 0.6	31.06	3.05	4.81	11.22	7.41	45.08
0.8	32.77	3.63	5.23	12.68	7.09	46.45
1.0	35.73	4.53	5.65	16.17	7.11	48.42
Vegetative and flowering stage	35.54	3.66	5.15	14.25	7.52	42.80
CD (P=0.05)	0.48	0.15	0.82	2.58	NS	2.48

Table 2 Productivity and profitability of vegetable pea under different irrigation schedules and PSB seed inoculation

Treatments	Green pod yield (q/ha)	WUE (kg/ha-cm)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
PSB treatment					
Un-inoculated	61.82	60.1	61 812	38 224	2.62
Inoculated	63.51	67.6	63 511	39 423	2.63
CD (P=0.05)	NS	-	NS	NS	NS
Irrigation schedule					
Sprinkler 0.6	49.98	97.0	49 983	26 670	2.14
0.8	58.50	66.3	58 502	34 488	2.44
1.0	72.36	79.7	72 365	48 352	3.01
Vegetative and flowering stage	69.82	51.3	69 795	45 782	2.91
CD (P=0.05)	4.13	-	4 135	4 135	0.17

but produced 19.2 and 30.9% higher green pod yield than IW: CPE 0.8 and 0.6 irrigation schedules, respectively. The lowest green pod yield was observed with sprinkler irrigation at IW: CPE 0.6 (49.98 q/ha). Although 2 irrigations were also applied in IW: CPE 0.8 ratio but probably did not coincide with the critical water need stages, hence, produced less green pod yield than IW: CPE 1.0 wherein the irrigation depth was same. Flood irrigation at vegetative and flowering stages was comparable with sprinkler irrigation at IW: CPE 1.0 treatment but excess water application through flood irrigation led to vigorous and continuous vegetative growth, thus non-uniform pod maturity, which is undesirable from harvesting view point. Pod discoloration was also observed in flood irrigation treatment.

Water use parameters

Seed inoculation with PSB recorded 11.1% higher WUE than no PSB treatment due to higher green pod yield. Irrigation scheduled at vegetative and flowering stages required more water (10 cm) leading to lower WUE (51.3 kg/ha-cm).Whereas, irrigation at 0.6 IW/CPE ratio needing the lowest amount of water (30 mm) exhibited higher WUE (97.0 kg/ha-cm) than other irrigation schedules (Table 2). Sprinkler irrigation at IW: CPE 1.0 (2 irrigations) saved 4 cm of irrigation water against conventional flood method (total depth 10 cm).

Economics

Computation of economics revealed that seed inoculation with PSB did not bring significant increase in gross, net return and B: C ratio over un-inoculated seed treatment (Table 2). However, sprinkler irrigation at IW: CPE 1.0 fetched maximum gross (₹ 63 511/ha), net return (₹ 61 812/ha) and B: C ratio (2.63) followed by flood irrigation at vegetative and flowering stages which were significantly higher than all other irrigation treatments (Table 2). This might be due to higher green pod yield under this treatment. Irrigation at IW: CPE 0.6 ratio with sprinklers recorded lowest gross, net return and B: C ratio. Findings of present study inferred that in a sandy loam soil, vegetable pea should be irrigated with sprinklers at IW: CPE ratio 1.0, however, PSB did not respond significantly.

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