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Morpho-Physiological Traits and Productivity on Garden Pea (*Pisum sativum* L.) As Influenced by Various Methods of Application of Potassium Humate 4.5

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A B S T R A C T

The field experiment was laid out in randomized block design with three replications to investigate the morpho-physiological traits and productivity of garden pea (*Pisum sativum* L. as influenced by the application of potassium humate. The experiment consisted seven treatment combinations and each treatment has common used of potassium humate 4.5 @ 5 lit/acre before basal dose of manure/fertilizers, which denoted by SA- Soil application, FA- foliar application and FA- foliar spray, described as T_1- control, T_2- SA + FS@5:250 of water after one month of 1st application, T_3- SA+ 2nd SA@ 5:150 after one month of FA, T_4- SA+ FS @ 5:250 after 45 days of 1st application, T_5- SA+ SA @ 5: 150 + after 30 days of 1st application + FA @ 3: 150 after 45 days of 2nd application, T_6- SA+ FS @ 5: 250 immediately after 1st picking and T_7- SA + FS @ 5: 250 after 15 days of 1st picking during rabi 2014-15. Among the different treatment combinations, T_5 had showed significant difference during phenophasic period except emergence and tendril formation, resulted highest yield attributing characters like number of nodes/ plant, filled pods/ plant (20.83), Seeds/ pod (4.51), pod length, green pod yield/ plant and seed yield (18.31 g/ plant & 20.38 qtl/ha) of garden pea over control; while, it was remained at par in terms of biological yield (41.55 qtl/ha) from T_4 (42.05 qtl/ha). The maximum harvest index recorded under T_3. Moreover, seed index was found to be non-significant but maximum with other treatments.

Introduction

Garden pea (*Pisum sativun L.*) belongs to the family Leguminoceae which is comprised of three subfamilies and approximately 15,000 species that exhibit diverse morphology habitat and ecology (*Denarie et al.*, 1992). Pea is an important *rabi* pulse crop of India and known as common name Mater (Hindi, Nepali) Pea; Field pea, Split pea, Garden pea, Seed pea, Shelling pea, Combining pea, Forage or Fodder pea, Dry pea, Feed pea, Vining pea (English). Pea was among the first crop cultivated by man who is highly productive grown for food, forage and vegetable. Pea is an important frost-hardy, cool season, nutritious leguminous vegetable that is widely cultivated throughout the world. It is a rich source of protein, amino acids, sugars, carbohydrates, vitamins A and C, calcium and phosphorus, besides having a small quantity of iron. Garden peas being

erect, remains erect while field peas have a tendency to climb when provided with a support. Plants bear tap root system with nodules on the surface. Stems are hollow, slender, succulent and ridged. It bears pinnately compound leaves with 3 pairs of leaflets and terminals are modified into branched tendril. Potassium humate is a complete organic molecule formed by the breakdown of organic matter in soil by micro-organisms and it is not a fertilizer. It is found in forest soil 2%-3% and rich in oxidized low rock coal, lignite, peat etc., major constituents of carbon and oxygen about 90%. Using potassium humate has a variety of benefits and it is applicable for all type of crops. Our land lost its fertility due-to prolonged and excess use of chemical fertilizers and pesticides. It improves physical property of soil, ion exchange capacity, water holding capacity and drought tolerance ability. This also prevents loss of nutrients from soil and act as a store house by keeping plant nutrients in soil. It increases crop yield and reduces the use of pesticide and chemical fertilizers. Our Indian soils are low in organic carbon. Due to intensive cultivation, organic matter and other nutrients are depleted from the soil. To compensate this, traditionally organic manure, compost, vermi compost and green manure are used in large quantities to achieve humic acid content in the soil. Application of potassium humate helps to build up organic matter content in the soil, enhancing water retention, cation exchange capacity, plant growth stimulant and helps to improve the yield of crops. Therefore the application of humate was tested as an approach to improve both the nutrient balance and plant vitality (Boehme *et al.,* 2005). Foliar sprays of these substances also promote growth, increases yield and quality in a number of plant species (Yildirim, 2007; Karakurt *et al.,* 2009). Applications of humic substances (HS) may help in achieving of increasing organic food production as HS applications are generally recommended in organic agriculture (Shahryari *et al.,* 2009). Therefore, an experiment was conducted to study the effect of various methods of potassium humate 4.5 applications on morpho-physiological traits and productivity of garden pea.

Materials and Methods

A field experiment was conducted at the Experimental area, Department of plant physiology, JNKVV, Jabalpur (M.P.) during *Rabi* Season of 2014-15. The soil of the experimental field was sandy clay loam in texture, slightly alkaline in reaction (pH 7.5), low in available nitrogen (245 Kg/ha) and phosphorus (7.99 Kg/ha) as well as medium in available potassium (348 Kg/ha) contents. The experiment was laid out in randomized block design, consisting total 7 treatments with 3 replications. A combination of 7 treatments viz. T_1 (only normal package of practices without application of potassium humate (control) T_2 (Soil application of potassium humate 4.5@ 5 liter/acre before the basal dose of manure/fertilizer+ foliar spray of potassium humate 4.5@ 5 liter in 250 liter of water after one month of 1st application), T_3 (Soil application of potassium humate 4.5@ 5 liter/acre before the basal dose of manure/ fertilizer + 2nd soil application 5 liter with 150 liter of water one month of the first application), T_4 (Soil application of potassium humate 4.5 @ 5 liter/acre before the basal dose of manure /fertilizer + foliar spray of potassium humate 4.5@ 5 liter in 250 liter of water after 45 days of 1st application), T_5 (Soil application of potassium humate 4.5@ 5 liter/ acre before the basal dose of manure/fertilizer + soil application of potassium humate 4.5 @ 5 liter in 150 litter of water + after 30 days of first application + foliar spray of potassium humate 4.5@ 3 liter in 150 litter of water after 45 days of 2nd application), T_6 (Soil application of potassium humate 4.5@ 5 liter/acre before the basal dose of manure/

fertilizer + foliar spray of potassium humate 4.5@ 5 liter in 250 liter of water immediately after 1st picking) and T_7 (Soil application of potassium humate 4.5@ 5 liter/acre before the basal dose of manure/fertilizer + foliar spray of potassium humate 4.5@ 5 liter in 250 liter of water after 15 days of 1st picking). The seeds were treated with carbendazim 2.5g/kg of seeds and rhizobium leguminosarum 10g/kg of seeds. Sowing of garden pea seeds was done on 8th November 2014 by hand dibbling. The Seeds @ 100 Kg/ha in rows 30 cm apart. Nitrogen, Phosphorus and potassium were applied at 30:70:40 Kg/ha NPK respectively in each lot. Irrigation was applied after sowing 1, 17, 35 and 53 days after sowing. The phenological changes were recorded through visual observations and sampling to analyze the dry matter production and partitioning efficiencies. The physiological traits and mechanisms viz., quantum efficiency, carboxylation efficiency, water use efficiency, mesophyll efficiency, canopy temperature, net photosynthetic rate and transpiration rate were measured by using infrared gas analyzer (IRGA). The observations were recorded on plant height (cm), number of nodes/plant, number of pods/plant, number of seeds/pod, number of filled pods/plant, 100- seed weight (g), Pod length (cm), pod width (mm), pod girth (mm), green pod yield (g/plant), seed yield (g/plant, Kg/ha), biological yield (g/plant and qtl/ha) and harvest index (%). The data were analyzed by using the 'Analysis of variance Technique' as per the procedures described by Synder and Corlson (1967). The treatment means were compared at 5% level of significance.

Results and Discussion

Marpho-physiological traits in garden pea

During the present study, the different treatments combination significantly influenced the morpho-physiological characters, and T_5 was recorded non-significantly earlier days to emergence than T_4, regardless to the application of T_6 treatment over control. Whether days to 2 to 4 leaf stage (10.33), flower initiation (34.67), 50% of flowering (39.33), pod initiation (41.33), seed formation (49.33), first picking (74.67), physiological maturity (103.67) and physical maturity (109.33) was lower than T_1, T_2, T_3 and T_4 during experimentation; while, the treatment T_6 and T_7 were shown in very earlier day over all the treatment for all respective characters. The early seedling emergence has the advantage of attaining the longer crop duration which may have better chances of producing early leaf formation and higher economic yield due to quit longer period of solar energy interception. The T_7 recorded in minimum days of time to attaining this stage. Whereas, days to 1st flower initiation exhibited significantly more time in T_1 (35.67) to acquire this stage than T_6 and T_7 and remained at par to T_2, T_3, T_4 and T_5 (34.67), respectively.

The flower initiation is an important phenological phases which determines the plant productivity in pigeonpea (Bhattacharya and Sharma, 2001). The significant correlation of early days to flower initiation with yield would be effective for improving in green pod yield in garden pea (Kumar *et al.*, 2008) and high positive significant correlation of days to first picking with nod number was noted at which first flower appears observed by Sharma and Sharma (2012). Similarly, T_7 took minimum time (38.33 days) and maximum in T_1 to attain this stage (Table 1).

However, in days to pod initiation significantly in T_6 recorded minimum days than T_1 taken longer period. But T_5 was remained at par to T_7 who closed to T_6 in study and T_7 resulted early seed formation.

Table.1 Various phenophases of garden pea under various treatments during crop growth period

Treatments	Days to seedling emergence	Days to 2 to 4 leaf stage	Days to tendril formation	Days to 1st flower initiation	Days to 50 % flowering	Days to pod initiation	Days to seed formation	Days to 1st picking	Days to Physiological maturity	Days to physical maturity
T_1	4.33	12.00	15.67	35.67	41.67	43.33	50.67	75.33	105.33	111.33
T_2	4.67	10.67	15.67	34.67	40.33	41.67	50.33	76.33	105.67	111.33
T_3	4.67	10.67	16.00	35.33	40.33	41.67	50.00	78.33	105.67	111.33
T_4	5.00	11.00	16.00	35.00	40.33	42.00	49.67	79.33	106.00	111.33
T_5	4.00	10.33	15.67	34.67	39.33	41.33	49.33	74.67	103.67	109.33
T_6	4.33	10.00	15.67	33.67	38.33	40.00	47.00	70.00	100.67	108.00
T_7	4.67	10.00	15.67	33.00	38.33	40.33	47.00	68.00	100.67	106.33
SEm ±	0.3	0.395	0.552	0.36	0.35	0.39	0.747	1.007	0.733	0.707
CD 5%	-	1.217	-	1.12	1.06	1.21	2.302	3.102	2.258	2.179

Table.2 Yield and yield contributing attributes in different treatments in garden pea

Treatments	I	II	III	IV	V	VI	VII	VIII	IX	X	XI		XII		XIII
											(a)	(b)	(a)	(b)	
T_1	81.87	15.07	14.80	14.27	3.83	23.55	6.90	9.60	3.20	59.69	10.53	16.60	23.41	36.60	45.47
T_2	78.80	16.13	16.73	15.93	4.23	23.75	7.23	9.92	3.31	68.23	13.37	19.16	25.17	38.20	50.36
T_3	74.67	16.13	16.00	15.20	4.26	23.47	7.21	10.37	3.46	65.52	12.40	18.91	19.90	33.52	56.41
T_4	73.87	21.67	21.53	20.80	4.49	24.44	7.43	10.19	3.40	75.30	16.79	19.87	34.22	42.05	47.30
T_5	77.07	22.30	21.40	20.83	4.51	24.46	7.81	10.58	3.53	105.04	18.31	20.38	29.53	41.55	49.05
T_6	81.47	16.67	15.60	15.07	4.11	23.47	7.59	10.86	3.62	61.68	12.16	17.70	23.50	37.35	47.47
T_7	77.87	20.53	18.93	18.33	4.32	23..83	7.35	10.83	3.61	70.87	14.89	19.25	27.48	38.26	50.54
SEm±	1.22	1.03	0.93	0.98	0.08	0.22	0.11	0.17	0.31	3.05	0.84	0.36	1.48	1.24	1.94
CD 5%	3.77	3.16	2.87	3.01	0.24	-	0.33	0.53	-	9.39	2.59	1.12	4.56	3.82	5.98

Remarks – I- Plant height (cm), II- No. of nodes /plant, III- No. of pods/ plant, IV- No. of filled pods/ plant, V- No. of seeds/ pod, VI-100 seeds weight (g), VII- Pod length (cm), VIII- Pod width (mm), IX- Pod girth (mm), X- Green pod yield (g/plant), XI (a) – Seed yield (g/plant) and (b)- in qtl/ha, XII (a)- Biological yield (g/plant) and (b)- in qtl/ha, XIII- Harvest index (%).

It's might be due to longer duration of pod set provides the optimum time to the pod for its extension which facilitates seed to expend conveniently without mechanical resistance provided by pod, of which T_5, T_4, T_3, T_2 and T_1 were remained at and on par to each other in sequences. Similar result was also seen in T_5 at third position after T_7 and T_6, respectively in days to 1st picking, physiological maturity and physical maturity. While T_6 and T_7 were found to be statistically similar to each other and same pattern also exist in T_2 and T_3 in physiological maturity; and T_1, T_2, T_3 and T_4 in physical maturity.

Effect of treatments on yield attributes and yields of garden pea

During the present study, plant height, number of nodes/plant, pods/plant, filled pods/plant, seeds/pod, pod length, pod width, green pod yield/plant, seed yield, biological yield and harvest index were found to be significant during experimentation. Among the treatment for respective traits, T_5 was shown outstanding characters by taking minimum days to attain plant height caused to significantly develop more pods/plant (22.30), filled pods/ plant (20.83), seeds/pod (4.51), pod length (7.81) and got highest green pod yield (105.04 gm) and seed yield (18.31 gm/ plant and 20.38 qtl/ha) over all the treatments except T_4, which was remained at par over in terms of I, II, IV, V, VI, VII, XI (a) and (b) during experimentation (Table- 2). However, the minimum qualitative traits observed under T_1. The higher number of nodes increases more chances of pod sifting which may results in production of higher number of pods which contributes directly to the economic productivity. The humic acid application @ 3 kg/ha significantly resulted in higher number of pods/plant in moong bean (Muhammad *et al.*, 2014). The higher number of seeds/pod appeared to have contributed remarkably in increasing the economic yield due to its direct involvement as sink component reported by Kumar *et al.*, (2013). While pod length was major yield contributing character and helped in improving the seed yield of garden pea (Katore and Navale, 2010). The number of pods/plant and number of seeds/pod were positively correlated with pod length (Kumar *et al.*, 2014). The green pod yield/plant had the highest positive direct effect of green pod yield in pea (Sarnik *et al.*, 1990). The highest biological yield and harvest index were notified significantly under T_4 and T_3, respectively over all treatment except T_5 in biological yield (41.55 qtl/ha). The lower economic yield in these treatments despite of higher harvest index may be attributed to the low mobilization of photo assimilates to the economic sinless of the plant and T_1 recorded lowest harvest index.

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