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Short Note

Effects of moisture stress on germination and seedling growth of vegetable pea (*Pisum sativum* L.) varieties

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Abstract

Climate change in various types of moisture stress will pose a major challenge for agricultural production. Keeping this in view a study was conducted with objectives of identifying suitable pea varieties for rainfed hill conditions through evaluating seed quality under moisture stress conditions imposed by PEG-6000 during germination and seedling growth. Among the varieties studied PE-6 along with VL-7 showed the highest tolerance against moisture stress as it maintained highest germination percentage, seedling length, seedling vigour index and root lipid content under the higher water potential.

Key words: Seedling vigour, germination, moisture stress, PEG 6000, root lipid content.

Pulses, also known as grain legumes, are next to cereals in terms of agricultural importance and have been considered as the best options for diversification and intensification of agriculture across the globe because of their intrinsic values such as nitrogen fixing ability, higher protein content and ability to thrive well in less endowed environments. Among the pulse crops, vegetable pea had important place in Uttarakhand, because pea is growing around the year and farmers of hilly areas take the advantage of off-season growing period and get handsome price. But nowadays, climate change is a major challenge for agriculture production system. There is an urgent need to dissect physical basis of stress environment like water stress, temperature, salinity and nutrient deficiency.

Seed germination and early seedling growth are critical for raising a successful crop as it determines the crop stand density and consequently the yield of the resultant crop, especially when germinating seeds are subjected to water stress in soil. However, the scanty information is available on vegetable pea varieties suitable for different growing conditions; germination behavior of certain crops and biochemical changes associated with germination under moisture stress. Therefore, present study was undertaken to investigate and quantify the effect of moisture stress on germination, seedling growth and change of total lipid content of roots in vegetable pea varieties.

An experiment was conducted in a completely randomized block design (CRBD) with four replication with 100 seeds in each replication. Five vegetable pea varieties viz. PSM-3, VL-7, PE-6, AP-3 and VRP-16 were treated with different water potentials viz. -3.0, -5.0, -7.5 and -10.0 bars, which were prepared separately by dissolving 11.5, 19.4, 23.5 and 28.9 g of polyethylene glycol-6000 (PEG) respectively, in 100 ml of distilled water. Distilled water was also used as control (0.0 bars). Seeds of each cultivar were previously disinfected by immersing in a 0.1 per cent mercuric chloride solution for five minutes. The seeds were then washed three times with sterilized distilled water. The seeds were put in germinator at 24±1 ^{0}C and moistened regularly with water or PEG-6000 solutions during germination. Seeds were considered germinated when the radical was at least 2mm long. Ten seedlings were taken randomly and seedling growth was measured by root length, shoot length and root: shoot ratio with 8-day-old seedlings. Total lipid was extracted from roots of eight day old seedlings of studied varieties, incubating them under different water potentials and measured gravimetrically. All statistical tests were carried out using the statistical analysis system (SAS Institute, 1996).

Germination of seeds decreased with increased moisture stress level because of the increasing solution concentration with increasing water potentials. The water and oxygen are essential for seed germination, but stress conditions reduced the levels of available water

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Table 1. Change in germination, shoot and root lengths of 8-day-old seedling of pea (*Pisum sativum* L) varieties under different water potentials

Water Potential (ψ)	Germination (%)					Average shoot length (cm)					Average Root Length (cm)					Root/Shoot Ratio				
	V_1	V_2	V_3	V_4	V_5	V_1	V_2	V_3	V_4	V_5	V_1	V_2	V_3	V_4	V_5	V_1	V_2	V_3	V_4	V_5
T_1	92.00	92.00	96.00	92.66	91.33	18.17	19.78	20.26	17.31	16.20	13.84	12.80	14.77	12.28	11.46	1.31	1.54	1.37	1.41	1.41
T_2	65.66	75.66	83.66	73.66	56.66	13.26	14.56	15.50	13.00	11.63	9.41	7.35	7.66	6.76	5.99	1.41	1.98	2.02	1.92	1.94
T_3	28.66	37.33	43.66	26.00	23.33	8.52	9.03	10.26	7.65	6.88	4.12	5.01	5.60	4.15	3.57	2.07	1.80	1.83	1.84	1.93
T_4	10.00	6.00	14.00	4.00	0.00	3.40	2.72	3.86	1.80	0.00	0.00	0.00	0.00	0.00	0.00	3.40	2.72	3.86	1.80	0.00
T_5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Variety	Treatment	Variety x Treatment			Variety	Treatment	Variety x Treatment			Variety	Treatment	Variety x Treatment			Variety	Treatment	Variety x Treatment		
$SE_m \pm 1$	0.78	0.78	1.76			0.11	0.11	0.26			0.96	0.96	0.21			0.15	0.15	0.35		
LSD at 0.05 %	2.98	2.98	6.68			0.45	0.45	1.01			0.36	0.36	0.81			0.59	0.59	0.13		
LSD at 0.05%	2.24	2.24	5.01			0.34	0.34	0.76			0.27	0.27	0.61			0.44	0.44	0.99		
CV %	7.55					5.73					6.82					3.99				

Whereas, V_1 = PSM-3, V_2 = VL-7, V_3 = PE-6, V_4 = AP-3 and V_5 = VRP-16
T_1 = Control, T_2 = -3.0 ψ, T_3 = - 5.0 ψ, T_4 = -7.5 ψ and T_5 = -10.0 ψ

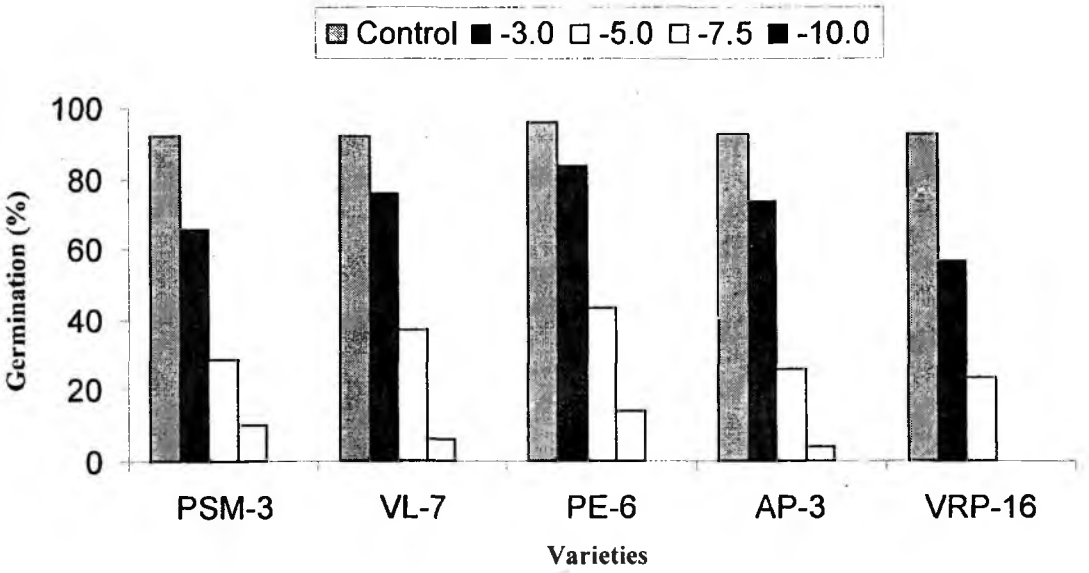


Fig 1. Germination percentage of vegetable pea varieties under different moisture stress treatments

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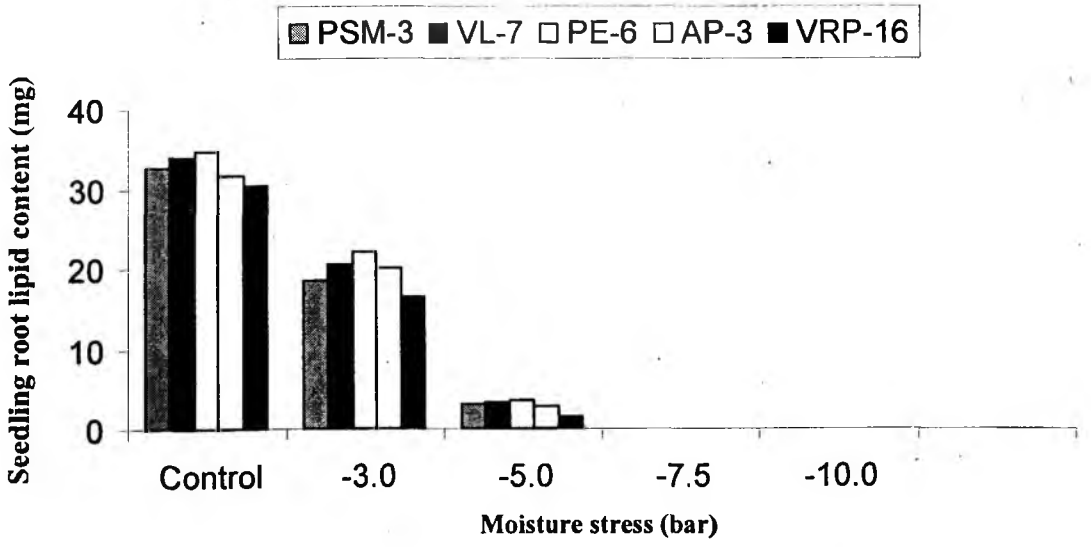


Fig 2. Seedling root lipid content (mg) of vegetable pea varieties under different moisture stress treatments

and oxygen uptake rates. Increasing stress levels resulted in delayed initial imbibitions which ultimately delayed the onset of germination under moisture stress condition. Germination stopped completely at -10.0 bar. The maximum germination was observed in the variety PE-6 (96.0 %) after eight days of incubation at 24±1 ^{0}C under control while, in other varieties viz. in PSM-3, VL-7, AP-3 and VRP-16, the germination was 92.0, 92.0, 92.66 and 91.33 per cent respectively (Table 1). Significant difference in germination percentage was observed at higher moisture stress levels. Higher water stress (-5.0, -7.5 and -10.0 bar) drastically decreased the germination per cent in all five varieties. Only 83.66 and 75.66 per cent germination was recorded in PE-6 and Vl-7 at -3.0 bar while, 43.33 and 37.33 per cent germination was observed at -5.0 bar in PE-6 and VL-7, respectively. At -7.5 bar only 14.0 per cent germination was observed in PE-6 and no germination was recorded in VRP-16. It seems that lowering the osmotic potential with decreasing water availability for seed caused low germination. Elevated drought stress slows down water uptake by seeds, thereby inhibiting their germination. Simon (1984) reported that low osmotic potential imposed by PEG inhibited the process of inbibition, germination and root elongation of cowpea. Germination and seedling growth was found to be decreased with increased moisture stress levels in vegetable pea (Kumar *et al.*, 1990) and (Pirdashti *et al.*, 2003) in rice seeds.

Analysis of variance showed significant interaction between moisture stress and varieties (Table-1). Significant reduction in average root and shoot length of seedling was found with increasing moisture stress. Maximum average root and shoot length was recorded in PE-6 at different water potential levels while, at -3.0 bar, PSM-3 had maximum root length followed by PE-6. Longer root system may be useful in maintaining water availability under limited moisture supply. Under moisture stress, it has been reported that the inhibition of radical emergence is mainly because of decrease in water potential gradient between the external environment and seeds (Murillo-Amador *et al.* 2002). Seed germination, root and shoot length of seedling decreased with increasing moisture stress which might be due to the higher molecular weight of PEG. Similar findings have been reported by Singh and Singh (1982) in wheat. However, according to Peters *et al.* (1967) growth of roots is reported to be less affected by water shortage than that of aerial parts.

Data on root: shoot ratio revealed that it increased with increasing water potential levels in all the studied varieties. Among varieties, the treatment maximum root: shoot ratio (3.86) were recorded at -7.5 bar. Whereas, among varieties, maximum root: shoot ratio (1.81) were found in PE-6 while, minimum root: shoot ratio were recorded for VRP-16 (1.12). Increasing root: shoot ratio with increasing moisture stress levels might be due to the fact that root tissues can continue to grow under increasing moisture stress that would eventually reduce shoot growth indicating the advantage of higher root: shoot ratio under higher moisture stress levels. This finding is in conformity with the findings of Westgate and Boyer (1985) who reported the inhibition of leaf, root, stem and silk growth at low water potential in maize.

There was marked reduction in total roots lipid content of eight day old seedlings with increasing water potentials. However, total lipid content remained higher in PE-6 followed by VL-7, AP-3, PSM, 3 and VRP-16 and this pattern closely resembled the germination patterns of these varieties. The present study revealed that the variety PE-6 exhibited better total roots lipid content at higher water potentials and showed higher germination percentage and seedling growth. Higher roots lipid content in PE-6 even at increasing water stress conditions appears to be significant in maintaining the membrane integrity of roots and providing energy to carry out essential metabolic processes during germination. The sharp reduction in total lipid content of roots under moisture stress conditions may either be due to its degradation during germination or lack of *de novo* synthesis as reported by Kumar *et al.* (1990) in vegetable pea. The present study showed that per cent germination and seedling growth were affected in all varieties of vegetable pea due to varied water potential levels and the variety PE-6 was found suitable to be grown under moisture stress conditions.

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