Himachal Journal of Agricultural Research 40(1):14-18 (2014)

Effect of FYM, mulching and irrigation scheduling on water use and productivity of garden pea (*Pisum sativum* L.)

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Manuscript Received: 10.01.2014; Accepted: 11.05.2014

Abstract

In order to study the effect of moisture conservation practices and irrigation scheduling on water use and productivity of garden pea, a field experiment was conducted in 2009-10, 2010-11 and 2011-12. The experiment was laid out in randomized block design with all possible combinations of three FYM levels viz. no FYM, FYM at the rate of 10 and 20 t ha^{-1}; two mulch levels viz. no mulch and rice straw mulching @ 10 t ha^{-1} and two irrigation schedules viz. irrigation at IW:CPE ratio of 0.6 and 0.8, replicated thrice. FYM was applied on wet weight basis and mulch was applied on dry weight basis as per the treatments, whereas irrigation was applied as surface irrigation. Results indicated that FYM application at the rate of 20 t ha^{-1} significantly increased pods plant^{-1}, green pod weight per plant^{-1}, seed weight pod^{-1}, green pod yield hectare^{-1} and WUE as compared to no FYM. Mulching with rice straw @ 10 t^{-1} ha increased pods plant^{-1}, green pod weight plant^{-1}, green pod yield hectare^{-1} and WUE. Irrigation at IW/CPE ratio of 0.8 increased pods plant^{-1} and green pod weight plant^{-1} compared to irrigation at IW/CPE ratio of 0.6.

Key words: FYM, mulch, IW/CPE ratio.

Introduction

Pea (*Pisum sativum* L.) a member of family Fabaceae, is grown in warmer regions as a pulse crop and is commonly called field pea. On the contrary, in colder region it is cultivated for vegetable and table purposes and called garden pea. It is very palatable and nutritious for human consumption and is taken either as fresh, canned, frozen or in dehydrated form. It is not only rich in nutrients, but being a legume crop, it also improves soil fertility.

In India, it is cultivated over an area of about 3,70,000 ha with an annual production of 35, 17, 000 metric tonnes (Anonymous 2011a). It is an important cash crop of Himachal Pradesh. The area under pea is rapidly increasing, especially under high and mid hill zones. The area under pea crop in Himachal Pradesh is 22, 800 ha with an annual production of 2, 54, 200 metric tonnes (Anonymous 2011b). The major pea producing areas fall in the districts of Lahaul-Spiti, Kinnaur, Shimla, Kullu, Solan and Mandi.

In high hill temperate zone (zone IV) of Himachal Pradesh, it is grown as irrigated summer crop, sown in March-June. On the contrary, in low and mid hill regions it is mostly grown as a rainfed *Rabi* crop. Due to non occurrence of rain during

October-December and March-June the crop is strongly influenced by low soil moisture content both during the initial growth stage as well as at pod formation or development stage. Inadequate soil moisture is a limiting factor not only in rainfed areas but also in kuhl (snow fed gravity stream) irrigated areas too, where, tail end farmers receive sub optimal irrigation water.

Water is a scarce input for irrigation and judicious use of water is of paramount importance. With rapid growth of population, urbanization and industrialization, water demand is increasing whereas, on the other hand water resources are shrinking, resulting in severe competition for water in agricultural and non agricultural sector. Irrigation facilities which are limited to 40.01 per cent of net sown area at national and 22.70 per cent of net sown area at state level, have very limited scope of expansion in near future. Under such circumstances, the only option left is economization of irrigation water through the use of moisture conservation techniques. Irrigation scheduling based upon climatic approach is an important aspect for efficient water management. Another way to conserve soil moisture is to apply mulches to the soil, which conserves the soil moisture by reducing the evaporation losses. FYM incorporation improves physical conditions of soil which, in turn, increases the infiltration and retention of water, improves soil aeration and moderates the soil temperature. Improvement in aeration and moisture supply help in better utilization of nutrients by plants which result in higher uptake of water and consequently better plant water status and growth. Keeping above factors in view an experiment was conducted to study the effect of FYM, mulch and irrigation scheduling on water use, productivity and profitability of garden pea.

Materials and Methods

A field experiment was conducted during *Rabi* 2009-10, 2010-11 and 2011-12 on acidic (pH 5.5), silty clay loam soils of CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (H.P.) which is located at $32^0 6^{'}$ N latitude and $76° 3^{'}$ E longitude, at an altitude of 1290.8 m above mean sea level. The organic carbon, available nitrogen, phosphorus and potassium were 0.98 %, 354, 36, 271 kg ha^{-1}, respectively. Agro-climatically the study area fall in mid hill sub humid zone covering about 15 per cent of the total geographical area of the state, endowed with mild summers and cool winters. Annual rainfall exceeds 2500 mm. Generally, more than 80 per cent of the total annual rainfall occurs during monsoon (June to September). Winter rains (December to February) are meagre and erratic and generally less than 15 per cent of total. In all 12 treatment combinations comprising of 3 levels of FYM, 2 levels of mulch and 2 irrigation schedules were tested in RBD (factorial) with three replications. FYM was applied before sowing in 10-15 cm deep furrows along with uniform dose of recommended NPK. Paddy straw mulch was applied at the rate of 10 t ha^{-1} after complete emergence taking care that plants are not covered with mulch material. As per treatment, surface irrigation of 5 cm depth was given to the crop. Observations on green pod yield and yield attributes were recorded. Sum of equivalent water depth of different layers recorded at different time interval from sowing till harvest was recorded as profile water use. Rainfall received after sowing and before harvest of pea crop was added to PWU for estimation of total water use from sowing to harvest. The water use efficiency was computed by dividing green pod yield (kg ha^{-1}) with total water use (mm).

Results and Discussion

Effect of FYM level

The seed weight pod^{-1} increased consistently with each increment of FYM; however, the increase was not significant when FYM was increased from 10 t ha^{-1} to 20 t ha^{-1}(Table 1). There was consistent and significant increase in number of pods $plant^{-1}$ with each increment of FYM. Application of FYM at

higher levels (20 t ha^{-1}) might have contributed towards better nutrition to the crop which has been reflected in producing more number of pods compared to lower level of FYM (10 t ha^{-1}). Jaipaul *et al.* (2011) also reported more pods $plant^{-1}$ with application of higher doses of FYM. Per plant green pod weight increased consistently and significantly with application of each additional increment of FYM. This increase in per plant green pod weight with increase in level of FYM application can be attributed to significant increase in number of pods $plant^{-1}$. Consistent and significant increase in pod yield of peas with increasing levels of farmyard manure can be attributed to improvement in yield attributes in response to improved nutrient and water status of soil. Slow release of nutrients from farmyard manure might have matched the crop demand throughout the crop duration. The improvement in physico-chemical properties due to application of FYM might have provided desirable soil condition for plant growth and nutrient uptake and thereby pod yield.

Increase in level of FYM resulted in consistent increase in water use efficiency, however, this increase in WUE was not significant when level of FYM was increased from 10 t ha^{-1} to 20 t ha^{-1}. Increase in FYM application from no FYM to 10 and 20 t ha^{-1} increased water use efficiency by 55.65 and 75.33 per cent. This increase in WUE can be attributed mainly to significant increase in green pod yield as there was no change in profile and total water use with increase in rate of FYM application (Table 2).

FYM application from zero to 10 t ha increased net returns (88.26 %) and B: C ratio (52.94 %) significantly, however, the increase in net returns as well as B:C ratio was not significant when FYM was

Table 1. Effect of FYM, mulch and irrigation schedule on yield attributes and green pod yield of garden pea

Treatment	Pods $plant^{-1}$	Green pod weight $plant^{-1}$ (g)	Seeds pod^{-1}	Seed weight pod^{-1} (g)	Pod yield (t ha^{-1})
FYM levels					
No FYM	22.13	109.55	5.38	4.18	6.81
FYM @ 10 t ha^{-1}	23.93	117.83	5.30	4.70	10.60
FYM @ 20 t ha^{-1}	29.43	145.32	5.29	4.98	11.94
CD (P=0.05)	1.32	6.63	NS	0.43	1.87
Mulch levels					
No mulch	23.63	117.13	5.43	4.56	9.01
Mulch @10 Mg ha^{-1}	26.7	131.33	5.22	4.68	10.55
CD (P = 0.05)	1.08	5.41	NS	NS	1.53
Irrigation schedule (IW: CPE ratio)					
Irrigation at IW/ CPE =0.6	24.34	120.19	5.43	4.54	9.24
Irrigation at IW/ CPE =0 .8	25.99	128.28	5.22	4.70	10.32
CD (P=0.05)	1.08	5.41	NS	NS	NS

further increased to 20 t ha^{-1} (Table 2).

Effect of mulch

Mulch levels did not influence number of seeds pod^{-1} and seed weight pod^{-1}. Application of mulch significantly increased green pod yield, which can be attributed to significant increase in number and weight of pods plant^{-1} (Table 1). Better nutrition and soil moisture status might be responsible for setting of more number of pods under mulch. Improvement in physical properties coupled with supply of water and nutrients under mulch might be responsible for this increase in pod yield. Similar results were obtained by Kumar 2001.

In spite of significant increase in profile water use, mulching of green pea significantly increased WUE (17.20 %) over no mulching. It is a clear reflection of the increase in green pod yield. Mulching significantly decreased B: C ratio due to increase in cost of cultivation but had no effect on net returns from green pea (Table 2).

Effect of irrigation scheduling

Irrigation schedules did not influence number of seeds pod^{-1} and seed weight pod^{-1}. Pods plant^{-1} and green pod weight plant^{-1} were significantly more in those plots where irrigation was scheduled at IW: CPE ratio of 0.8 than in those plots where irrigation was scheduled at IW: CPE ratio of 0.6 (Table 1). Similar increase in pods plant^{-1} with increase in irrigation was reported by Dhar and Singh (1995). Though scheduling of irrigation at IW: CPE ratio of 0.8 resulted in higher pod yield than scheduling of irrigation at IW: CPE ratio of 0.6, however, differences in yields were not significant statistically. Kaushik and Chaubey (2003) also reported similar

Table 2. Effect of FYM, mulch and irrigation schedule on profile water use, total water use and on water use efficiency during growing season of garden pea

Treatment	Profile water use	Total water use	Water use efficiency (kg pod ha-mm^{-1})	Net returns (Rs ha^{-1})	B:C ratio
FYM levels					
No FYM	110.09	437	15.55	35, 783	1.19
FYM @ 10 Mg ha^{-1}	114.32	437	24.17	67, 364	1.82
FYM @ 20 Mg ha^{-1}	116.40	437	27.32	74, 682	1.73
CD(P=0.05)	NS	-	4.22	18,678	0.51
Mulch levels					
No mulch	108.94	437	20.58	59, 781	1.93
Mulch @10 Mg ha^{-1}	118.27	437	24.12	58, 772	1.23
CD (P = 0.05)	6.86	-	3.45	NS	0.42
Irrigation schedule (IW: CPE ratio)					
Irrigation at IW/ CPE = 0.6	98.79	421	21.97	53, 880	1.42
Irrigation at IW/ CPE = 0.8	128.42	454	22.73	64, 672	1.74
CD (P=0.05)	6.86	-	NS	NS	NS

results. In spite of lower water use under irrigation schedule of IW/CPE ratio of 0.6 than under irrigation schedule of IW/CPE ratio of 0.8, water use efficiency did not change significantly. Similarly, irrigation schedule had no effect on economics (Table 2).

Conclusion

For economization of irrigation water and maximization of green pod production, pea crop should be sown after incorporation of FYM @ 20t ha^{-1} and should be mulched with paddy straw @ 10 t ha^{-1} immediately after emergence. The crop should be irrigated with water depth of 5 cm at IW: CPE ratio 0.8

Acknowledgement

The authors feel privileged to thank the Indian Council of Agricultural Research for the financial help to carry out this work by way of sponsoring the All India Coordinated Research Project on Water Management at CSK HPKV, Palampur (Himachal Pradesh).

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