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Response of irrigation techniques and mulching to water economy of potato (*Solanum tuberosum* L.)

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Abstract
A field experiment was conducted during Rabi season of 2005-06 and 2006-07 at Faizabad to evaluate irrigation techniques with mulching for water economy in relation to growth, yield and quality of potato. All the growth, yield and quality parameters were higher when irrigation was provided to each furrow at 25mm CPE along with mulching, however, irrigation at stolen formation, tuber initiation ant tuber development stages along with mulching incurred maximum benefit: cost ratio and showed economic viability by saving 66 per cent of irrigation water.

Keywords: Genetic combining ability, Specific combining ability, Okra, Variance

Introduction
Water is the key input in potato production, which drastically reduces the yield even after a short stress at tuber formation stage. The optimum soil moisture is needed to be maintained in the root zone to meet the crop requirement for higher yield; however, its management problem varies from irrigation to irrigation. The drip and sprinkler irrigation are the improved irrigation techniques, which save about 30 – 50 per cent water and has become very popular in water deficient regions like Gujrat and Maharashtra. However, its adoption is restricted mainly due to high initial investment for the short duration crop like potato and technical knowledge to operate (Bhan and Dhama, 1982) [1]. In this context, mulching is also one of the important cultural operations, which are employed to conserve the soil moisture, regulate the soil temperature, suppress the weed growth, posses the fertility and improve the texture of soil. Besides, paddy straw mulching adds organic matter and nutrients in the soil, which in turn increases yield. Zaman *et al.* (2009) [15] recorded higher yield of potato with paddy straw mulch than others. The literatures available on irrigation techniques and mulching are scanty. Therefore, the present experiment was conducted to work out the appropriate technique of irrigation along with mulching, which is economically viable for optimum growth, yield and quality of potato.

Materials and Methods
A field experiment was conducted during the *Rabi* season of 2005-06 and repeated subsequently during 2006-07. The soil of experimental plot was sandy loam with slightly alkaline in reaction. Eight treatment combinations comprises of 4 irrigation techniques (I_1: Irrigation to each furrows at 25mm CPE, I_2: Irrigation to alternate furrows at 25mm CPE, I_3: Irrigation to stolen formation, tuberization and tuber development stages and I_4: I_3 + one extra irrigation 10 days after 10 preceding irrigation) and two mulching treatments (with and without mulching with paddy straw @ 5t/ha) were evaluated in randomized block design with four replications at MES, Department of Vegetable Science, ND University of Agriculture & Technology, Kumarganj, Faizabad, U.P. Farm Yard Manure (FYM) @ 20 t/ha was incorporated into the soil at last ploughing. Potato tubers of cv Kufri Arun were planted at 60 x 20cm spacing in the month of November. A uniform basal dose of 75 kg N, 100 kg P and 120 kg K/ha in the bands below the seed tubers was applied at the time of planting and remaining 75 kgN was top dressed in the furrow at the time of earthing up of the crop. The crop was raised under recommended package of practices except irrigation, which was applied as per treatment up to depth of 5 cm. The crop was dehaulmed manually at full maturity (90 days after planting) and harvesting was made two weeks later after peel setting.
Plant stand was maintained and the final emergence count was taken at 30 days after planting (DAP). The response of potato to various treatments were measured in terms of quantitative expression i.e. per cent emergence, number of shoots per hill, plant height, number of leaves per plant, grade wise number and weight of tubers per plot and yield of tubers per hectare, quality parameters like dry matter, protein, starch and ascorbic acid content in tubers. Tubers

(DNS) reagent method described by (Rangana 1986), while protein was estimated by using (Lowery's method, 1951). Economic feasibility of various treatments was also calculated. Data gathered on various aspects for both the years were pooled and statistically analysed by the standard procedure described by (Gomez and Gomez, 1984) [3] and results were discussed at 5 per cent probability levels to draw valid conclusions.

Results and Discussion

Effect of Irrigation

Per cent emergence as well as number of shoots per hill did not varied significantly due to various irrigation techniques and mulching with paddy straw. It t may be attributed to the food materials already stored in the seed tubers, which initially boost up to emergence and size of tubers, number of eyes on seed tubers, nature of apical dominance and common irrigation, which appear to be the similar for all treatments that might have resulted similar responses for all treatments. The results are in close conformity with the findings of (Bhatia *et al*., 1992).

Plant height and number of compound leaves per hill were influenced significantly due to various irrigation techniques and maximum values under both the parameters were recorded with irrigation to each furrow at 25mm CPE, which may be due to meristematic activities favoured by adequate water supply for the maintenance of turgidity of the cells. Higher number of foliage may primarily be due to balancing effect of water on growth promoting hormones against abscisic acid formation in the leaves. Similar findings have also been made by Grewal and Singh (1978) [4], Hooda *et al.* (1979) [5] and Wolf *et al.* (1983) [14].

Total number (5.26) and weight of tubers (329.20g) per hill were statistically higher under irrigation to each furrow at 25mm CPE; however, minimum values of the parameters were noted under irrigation to alternate furrow at 25mm CPE. The increase in the parameters with irrigation to each furrow at 25 mm CPE may be due to avoidance of moisture stress during stolen formation and elongation. Hukkeri *et al.* (1970) [7], Valoon (1981) [13] and Saikia (2011) [11] also reported the similar findings.

The yield of different grade as well as total tubers varied significantly due to various irrigation techniques except 25-50g size tubers, which remained unaffected. Maximum yield of B, C and D grade tubers were recorded when irrigation was applied to stolen formation, tuber initiation and development stages, however, A grade and total tuber yield (t/ha) were highest when irrigation was given at 25mm CPE to each furrow. Tuber is the vegetative part of potato plant whose development depends upon the supply of carbohydrates. Better growth and development of potato is directly associated with adequate moisture, which are essential for maintaining the leaves in turgid and enlargement of tubers. The irrigation to each furrow at 25 mm CPE produced taller plants and more number of leaves per hill and accelerated the photosynthesis activity which ultimately increased the total yield of potato. The results tally with the findings of Valoon (1981) [13] and Saikia (2011) [11]. However, irrigation to alternate furrow at 25 mm CPE educed 16% yield than to irrigation to each furrow at 25mm CPE. Biswas *et al.* (1995) [2] also reported 18.84 % reduction in yield with applying water in alternate rows.

Effect of Mulching

The per cent sprout emergence and number of shoots per hill were remained unaffected due to mulching with paddy straw @ 5 t/ha, however, slight improvements were noticed over unmulched treatment. It may probably be due to food materials already stored in the tubers and almost similar size of tubers. The plants under mulching treatment attained significantly more height and number of leaves per plant as compared to unmulched treatments. The progressive increase in the parameters may be attributed to the fact that the organic mulching added organic matter and plant nutrients to the soil after decomposition, which in turn increased the vegetative yield. The findings of Ram and Singh (1992) and Gupta and Awasthi (1997) also tally with the present results.

Tuber number and weight per hill as well as weight of all grades tubers except 25-50 g and< 25g size tubers were significantly higher in the treatment with paddy straw mulching. The progressive increase in the parameters owing to mulching provided congenial environment for tuber development by maintaining soil temperature and conserving soil moisture. Paddy straw mulch also returns plant nutrients to the soil after decomposition, which in turn increased the parameters by increasing vegetative yield. The results are in agreement with the findings of Huang (2000) [6] and Rahman *et al.* (2004) [9].

All the quality parameters i.e. dry matter, protein, starch and ascorbic acid contents varied significantly due to mulching with paddy straw and surpassed by the margin of 4.95, 11.47, 3.91 and 7.4 per cent, respectively over without mulching treatment. Trifonova (1980) [12] also made similar results.

Economics

Irrigation to each furrow at 25mm CPE along with mulching with paddy straw involved maximum cultivation cost and gross return, however, benefit : cost ratio was incurred maximum under irrigation at stolen formation, tuber initiation and tuber development stages + one extra irrigation. The high cultivation cost and gross return was mainly due to more involvement of initial input like irrigation water and mulch, and higher yield under this treatment, however, the fluctuation in benefit: cost ratio may be due to variation in initial input involved and yield of crop under different treatments. The findings are in close conformity with the findings of Rahman *et al.* (2004) [9].

On the basis of above findings it may be concluded that irrigation to each furrow at 25mm CPE along with mulching was more effective for growth, yield and quality parameters, however, the irrigation at stolen formation, tuber initiation and tuber development stages and mulching with paddy straw & 5 t/ha was more economically viable than rest of the treatments. It also found to be economical in view of saving irrigation water by 66 per cent.

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