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Innovative technology of water chestnut in association of paddy-wheat cropping system under submerged condition for increasing two fold income of farmers. (SRA Model-5)

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Abstract

The study was under taken in low land submerged condition from 2002-03 to 2005-06 at adjoining village of Sultanganj block of Mainpuri. The main objective was to increase the farm families net income more than two fold. The secondary objective was to develop the feasibility of water chestnut associated cropping system with submergence paddy and after harvesting of paddy and picking of water chestnut fruits, wheat sowing under organic farming on green manuring of water chestnut green biomass left after nuts reaping and nitrogen fixation by blue green algae and available of native phosphorus. The soil of pilot area was clay loam, having low to high nutrients status. Three cropping systems i.e. paddy + water chestnut-wheat K 7903, paddy + water chestnut – wheat K 9423 and paddy + water chestnut-wheat PBW 373 were tested. The main crop of paddy under associated cropping system of water chestnut, yielded grains by 40.00q/ha. The associated crop of water chestnut produced average yield of nuts as 80.00 q/ha. The average grain yield of wheat cultivars was reaped by 35.00 q/ha under late sown condition. Among the wheat cultivars, the highest average grain yield harvested from PBW 373 by 36.40 q/ha, closely followed by K-9423 (36.10 q/ha), while minimum average yield 32.50 q/ha produced by K-7903. The system productivity was computed by 135.56 q/ha. The gross return, net return and BCR were obtained by Rs. 74,400/ha, Rs. 26,935/ha and 1:1.56, respectively, from harvesting of main crop of paddy. The associated crop of water chestnut grown with paddy was recorded gross return Rs. 1,20,000.00/ha, net return Rs. 49,500/ha and BCR 1:1.70. The gross return Rs. 57,750/ha, net return Rs. 18250/ha and BCR 1:1.46 were noted from the cultivation of late sown wheat in cropping system of paddy + water chestnut-wheat.

Keywords: Fold, Low land, Monoculture, Submergence, Water chestnut.

Introduction

Ecologically paddy is a semi aquatic plant, but it thrives under submerged conditions. It has the highest water requirement among the cereals of similar duration. Its water requirement generally ranges from 900 to 1000 mm with extremes of 520 and 2549 mm in a crop season. Therefore, one cannot produce a crop on stored moisture or under infrequent rain, unlike other cereals and an adequate supply of water is required for maximum yield. The submergence may enhance the fixation of nitrogen by blue green algae and other organism and increase the availability of both the native phosphorus and applied fertilizer. The submergence makes the decomposition of organic matter in soil slower and controls the waste of soil fertility. As water has high specific heat the submergence may protect the paddy from cold damage in cool period. Under continuous submergence condition paddy yield noted highest grains by 40.95 q/ha with water use efficiency 2**.**12 kg/mm/ha of water (Verma and Singh, 1987).

Under subemergent condition varieties play important role in grain production. Amongst deep water paddies, Mahsuri and NDGR 201 are recommended varieties, which is popular in water stagnate situation (Anonymous, 2020). The deep water resistant paddy varieties gives flower by end of October are harvested towards the third week of December. The main characteristics of these varieties, they can with stand complete submergence without much detrimental effect on yield. Therefore, the submergence varieties of rice are usually sown broadcast/transplant in due time when the land is dry and are harvested at end of the year.

The water chestnut (*Trapa natans* Linn.) called *Singhara* in Hindi is an aquatic herb floating in fresh water ponds. It has long flexuous stem, triangular leaves, white flowers and two spiny fruits which are ascending on water. Therefore, water chestnut, fruits contain citric acid, tannin, amylose, amylopectin, carbohydrate, beta-amylose, phosphorylase, protein, fat, nicotinic acid, riboflavin, thiamine, vitamins A & C and manganese. Its fruits are used as medicine in several diseases. After picking of *Singhara* fruits the rest green biomass left in the ponds or growing piece of land. After water receding from growing piece of land partial green matter is decompose and rest dry up in situ. The decomposed green material developed organic matter richness in the growing piece of land (Singh *et al*. 2019 and Singh *et al.*, 2019).

After harvesting of paddy and picking of water chestnut fruits, the late sown varieties K 9533, K 9162, K9423 and K 7903 of wheat can easily be grown, which mature between 85 to 110 days with productivity of 40-45 q/ha (Anonymous, 2020).

It is well known fact that paddy and water chestnut are rainy season crops. But in the eye of scientists paddy is vertical nature crop, while water chestnut is horizontal crop. In other words can say that paddy is standing field crop and water chestnut is spreading horticultural crop. Both crops are water loving and their requirement of agronomical practices different, therefore, the companion cropping between these two crops was much difficult but authors of paper Regional Research Station, Mainpuri, C.S. Azad University of Agriculture and Technology, Kanpur makes feasible practice of companion cropping in submergence condition. If chances increase in yield reduction of paddy, companion crop water chestnut meets out this reduction.

Most of the farming community leaves the fields vacant after harvesting of paddy crop and plucking water chestnut fruits, and, thus, loss the rabi season crop. Under such condition farming majority advocated for sowing of late sown wheat with cultivars K 9533, K 9162, K9423 and K 7903 on residual soil moisture. Therefore, in the same piece of land, the farmers are harvest three crops and earn the two or more than two fold net income. This system generated additional employment to the farm families. Now-a-day the farm families of this locality are harvesting the fruits of newly generated technology.

The associated cropping system of paddy + water chestnut and late sown wheat is the subject matter of this manuscript.

Materials and Methods

The field study was under taken in submergence paddy growing area during rainy and winter seasons of 2002-03 to 2005-06 in adjoining village of Sultanganj block of Mainpuri on farmers fields. The main objective was to increase the farmers net income more than two fold. The secondary objective was to develop the feasibility of water chestnut associated cropping system with submergence paddy and after harvesting paddy and picking of water chestnut fruits, wheat sowing under organic farming on green manuring of water chestnut green biomass left after nut reaping and

improve the fertility status of soil. The soil samples were collected from the representative area and composite sample drawn for nutrients analysis. The experimental soil was clay loam having pH 7.9, organic carbon 0.49%, total nitrogen 0.04%, available phosphorus 9.8 kg/ha and available potassium 281 kg/ha, thus nutrients of experimental soil was low to high. The pH was determined by Electrometric glass electrode method (Piper, 1950), while organic carbon was determined by Colorimetric method (Datta *et al*., 1962). Total nitrogen was analyzed by Kjendahl's method as discussed by Piper (1950). The available phosphorus and potassium were determined by Olsen's method (Olsen *et al*., 1954) and Flame photometric method (Singh, 1971), respectively. Three cropping systems i.e. paddy + water chestnut-wheat K 7903, paddy + water chestnut - wheat K-9423 and paddy + water chestnut – wheat PBW 373 were tested. The paddy seedling of cv. NDGR 201 or available nursery of farmers was transplanted in first week of July under standing water condition at the distance of 100 cm. The wider spacing was maintained between two rows of paddy due to the spreading of water chestnut cuttings and picking of fruits. For obtaining good plant stand of paddy through tillering, four healthy seedlings were transplanted in one place. The paddy crop was harvested in last week of December after complete grain maturity during four experimental years. When height of stagnated water increased the water chestnut cv. *Kanpuri* cuttings were uniformly broadcasted between the distances of two paddy rows. In rows of 100 cm, cuttings spread very carefully without any damage of well established paddy plants. The water chestnut cutting broadcasted in last week of July and picking of nuts were started in the last week of October and plucked up to second fortnight of December in study period. The recommended agronomical practices were followed in the cultivation of water chestnut. After last picking about 150 q/ha green biomass of water chestnut was turned up into soil for green manuring. Due to tenderness, it rotten very fast, After rotting of green biomass, field was pulverized through ploughing for sowing of wheat. The wheat sowing was started from the last week of December and continued till first fortnight of January in every year of study period. The wheat varieties K-7903, K-9423 and PBW-373 were planted under late sown condition and these varieties harvested after 90-100 days after sowing. The recommended natural farming practices were followed. The irrigations were given to wheat at short intervals.

Results and Discussion

The pooled data of two years have been recorded and reported in Table-1 and discussed here under appropriate heads-

(A) System productivity: Perusal of data make it clear that the main crop of paddy under associate cropping system of water chestnut yielded grains by 40.00 q/ha. The yield reduction of paddy in comparison to pure crop planted by farmers themselves was due to plant reduction. The associated crop of water chestnut produced average yield of nuts as 80.00 q/ha. At initial years of productivity of nuts was found lesser over the last year observation. This was due to experience of farmers, which engaged as participants in the study. The average grain yield of wheat cultivars was reaped by 35.00 q/ha under late sown condition. Among the wheat cultivars, the highest average grain yield harvested from PBW 373 by 36.40 q/ha while minimum average yield 32.50 q/ha produced by K-7903 under late sown condition. Cultivar K-9423 yielded average grain yield by 36.10 q/ha. The higher and lower productivity of late sown wheat was due to genetic variability. The system productivity was computed by 135.56 q/ha. These results are in agreement with those reported by Singh *et al.* (2019), Singh *et al.* (2019) and Singh *et al.* (2020).

(B) System profitability: The cost of cultivation of paddy was calculated by Rs. 47465/ha. The gross return, net return and BCR were obtained by Rs. 74400/ha, Rs 26935/ha and 1:1.56, respectively. Similarly, associated crop of water chestnut grown with paddy was recorded cost of cultivation Rs. 70500/ha, gross return Rs. 1,20,000/ha, net return Rs. 49500/ha and BCR 1:1.70, cost of cultivation for raising of late sown was recorded by Rs. 39500/ha. The gross return, net profit and BCR were computed by Rs. 57750/ha, Rs. 18250/ha and 1:1.46, respectively. Therefore, net profit increased by inclusion of water chestnut as associated crop in cropping system as compared to local practice of paddy-wheat rotation. Similar results have also been reported by Singh *et al.* (2017) and Singh *et al.* (2020).

Net income increase in fold:

Net profit results clearly displayed that inclusion of water chestnut in cropping system of paddy + water chestnut – late sown wheat increased the income of farm families more than 2 fold (Table-1). These results are commensurable to the findings of Singh *et al.* (2019) and Singh *et al.* (2020).

Table-1: Yield and net income generated from paddy + water chestnut-late sown wheat cropping system. (*Pooled data of four years*)

S.N.	Treatment	Yield (q/ha)			System productivity (q/ha)	System Profitability (Rs./ha)			BCR	Net Income increase in fold
		Paddy	Water chestnut	Wheat		Cost of cultivation	Gross return	Net return		
1.	Paddy+water chestnut-wheat PBW-373	40.00	80.00	36.40	136.80	157465	254460	96995	1.62	2.04
2.	Paddy+water chestnut-wheat K-7903	40.00	81.00	32.50	134.15	157465	249225	92060	1.58	2.24
3.	Paddy+water chestnut-wheat K-9423	40.00	79.00	36.10	135.72	157465	252465	95000	1.60	2.02
	Mean	40.00	80.00	35.00	135.56	157465	252150	94685	1.60	2.10

Market sale rate of enterprises

1. Paddy – Rs. 1860.00 /quintal
2. Wheat – Rs. 1650.00 / quintal
3. Water chestnut – Rs. 1500.00/ quintal

Conclusion

The farm families residing in the submerged paddy growing area, where monoculture cultivation of paddy or some time paddy – late sown wheat cultivation in tit-bit may be advocated for paddy + water chestnut – late sown wheat cropping system adoption for increasing farm net income >2 fold.

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