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SUSTAINABLE RICE-DUCK INTEGRATION FOR CLIMATE RESILIENCE AND ENVIRONMENTAL VERSATILITY

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ABSTRACT

Rice cultivation with ducks possibly offers biological assistance ,and efficient control of weeds. Present research was conducted to trace the viability of coordinating duck in rice cultivation for controlling weed pervasions and their effects on efficiency and economic output of the framework. Examination on variety of weeds showed that lush weeds (*Echinochola colona, Echinochola crusgalli)* and sedges (*Cyperus difformis, Cyperus iria, Fimbristylis miliaceae*) were predominant in rice during tillering stages, while broad leaved weeds (*Ludwigia adscendens, Sphenoclea zeylanica*) and aquatic weeds (*Marsilia quadrifolia*, *Hydrilla verticillata*) were abundant during dynamic tillering and panicle commencement phases of rice. For two years in a row, field research was done at the experimental farm of Bharath University to trace the impact of duck integration in the transplanted rice crop. The purpose of the experiment was to trace the impact of duck integration performed in three different scenarios: duck herding in puddled fields, duck herding in transplanted fields, and duck herding in both transplanted and puddled fields. The field study was set up using a split plot design with three sub treatments that were replicated three times. All of the treatments utilizing different duck integration techniques led to significantly higher grain and straw yields as well as corresponding reductions in weed metrics attribute to the interactions that result from herding ducks. Duck herding under all procedures involving diverse duck integration techniques dramatically boosted grain and straw yield while concurrently lowering weed characteristics. The interactions that result from herding ducks, the overall weed population was lowered by the combined effects of duck herding in cropped and puddled conditions, cono-weeding, and one-handed weeding, recording 5.77 and 5.67 per m2 during I and II season, respectively. Similarly crop DMP, grain yield and straw yield increased by 15.03 t ha-1, 4.34 t ha-1, and 7.29 t ha-1 during the first season, and 15.3 t ha-1, 4.88 t ha-1, 7.58 t ha-1 during the second season respectively due to duck integration in rice production

Key words: (Cono weeding, growing rice, duck herding, grain yield, straw yield and weed control.)

Introduction

Rice (*Oryza sativa* Linn.) dominates as the principle staple food for many people living on the planet. Globally, rice occupies an area of 158 million hectares and 744.9 million tons produced worldwide (FAO, 2014). Rice is often developed in different environments (flood/rainfed and upland) where performance depends on different biotic and abiotic stresses (Choudhary, Suri, 2014; Kaur et al., 2015). Among various biotic stresses, weeds are considered as one of the most important stress factors affecting rice yield (Dass et al., 2017). Weed severity is believed to have caused extreme rice losses of 40-60% in transplanted rice and 70-80% in direct sown rice (Chauhan and Johnson, 2011; Dass et al., 2017). Thus, in rice production, weed control is considered urgent, which is due to the competition as light, space, nutrients, decrease in rice production. . Since manual weeding is labor-intensive and generally uneconomical, smallholders move step by step and prefer herbicide for weed control, which introduces natural biases and expected ecological hazards such as weed migration, weed control and phyto toxicity in crops (Gnanavel et al., 2014 ; Dass et al., 2017; Ramesh et al., 2017). Marine climates are generally defense less to herbicides, resulting in a decrease in dissolved oxygen, a decrease in pH, and an increase in the interest of organic oxygen in the water, which directly or indirectly influenced or interpreted harmful effects to various beneficial effects living organisms, especially microorganisms. (microscopic organisms, parasites and protozoa) which disrupts the natural adaptive system of microbes, useful organic units and their subsequent biodiversity (Kalia and Gupta, 2004). About 20 million hectares of the 43 million hectares of rice developed in India are acceptable for a rice-fish coordinated farming framework (Rao Edasi, Singh, 1998; Mohanty et al., 2010). In addition, mixing rice with fish and ducks has beneficial effects on, for example, lower energy use, wasteful recycling, better preparedness for environmental management, which leads to sustainability of creation (Nayak et al., 2018a; 2018b; 2020). Therefore, the rice-fish-duck combination can continue with the efficiency of rice at conventional or newer levels than conventional agriculture, which may involve higher costs of labor and agrochemicals. In contrast, mixing with fish or ducks can reduce the use of agrochemicals while improving the environment and the quality of the rice crop (Zhang et al., 2009; Suh et al., 2014; Nayak et al., 2020). Also, the cultivation of rice fish and rice duck can potentially mitigate dangerous atmospheric destruction by reducing methane emissions (Xu et al., 2017; Zhao et al., 2019; Nayak et al., 2020) and potentially control atmospheric emissions golden apple snail *Pomacea canaliculata* (Liang et al., 2014). Evidence also showed that the use of fish, duck and poultry parts contributed to weed control in addition to improving rice performance (Sinhababu et al., 2009; Long et al., 2013; Sinhababu et al., 2013.; Mofidian and Sadeghi, 2015; Wei et al., 2019). Therefore, paddy cultivation is recognized as a sustainable agro ecological practice worldwide (Hu et al., 2016; Wei et al., 2019; Nayak et al., 2020). Considering the general ecological well-being of the rice environment, the development of eco-efficient agrarian weed control methods is of utmost importance because seeds and design adaptations can be adapted to reduce weed threat (Dass et al., 2017).). Even so, fish and ducks in coordinated agriculture can provide comprehensive ecologically adaptive weed control and in addition advanced approaches useful in organizing need destruction, jobs, and health security for the unfortunate smallholder farming network of the property. Comprehensive knowledge about weed control agents and their suitability to improve the efficiency of biological systems in storm water wetlands is scarce, especially in the practice of rice- duck coordination. Thus, the focus was on the relative viability of rice- -duck coordination in terms of weed reduction, the effectiveness of their framework, and the economic aspect. The aim of the work was to find out the prevalence of weeds in rice fields transplanted into swamps; study the viability of ducks in weed control; assess the impact of duck on rice production and rice content and focus on the professionalism, efficiency and financial aspects of the framework .

Due to its multifaceted dynamism in sustainable production, soil health, biodiversity protection, and natural resource management, which leads to social, economic, and environmental benefits, environmental concern is distinct and is being fulfilled in all situations. The primary goal of the integrated farming system, by far, is to handle the vertical expansion of land usage in agriculture while enhancing self-sustainability, ecological soundness, and increased farm output. By minimizing the use of pesticides, boosting productivity, and providing farmers with an additional source of income, the rice duck farming method intends to assist environmental adaptability in rice agriculture as well as contribute to food and economic security in the area. It has been demonstrated that adding ducks to rice farming increases output by 20% and net profit by 50%. In addition to producing rice, the same growing area can also produce ancillary goods like meat and eggs. Additionally, it decreases labor requirements by using ducks to eliminate weeds and insects. In addition to its financial advantages, this technology is particularly eco-friendly,reducing the use of synthetic fertilizers and pesticides can improve soil quality[FAO ,2020].

Progress in the economy, human health, and education over the past few decades has altered national beliefs and demographics, and India is no exception. Half of the world's population depends on rice, which is the most important staple food crop; 130 million tonnes of rice are predicted to be produced by 2030 AD, up from the 102.75 million tonnes that are currently produced. The rice crop in Tamilnadu covers 44.6 m.ha and produces 90 mt [FAO 2014], however the degree of productivity is quite poor. A systematic program throughout the full farming season through a series is needed to improve the efficiency of the farming system as a whole. Rice-duck integration needs to be investigated as food production moves toward higher sustainability. Combining rice farming and duck breeding is the best technique to produce rice using an organic cultivation approach.(Hosseyni Kheshtimasjedi H. (2008) ;Liang etal 2012; Wangchengyuh (2001)

Duck farming intentionally has a significant role adjacent to chicken farming since ducks are generally quite resilient, more readily brooded, resistant to major avian diseases, requiring less attention, and prospering in scavenging settings. A Japanese scientist established duck herding in paddy fields for scavenging on weeds, crop wastes, snails, and fresh water crustaceans in North Vietnam in 1994. In the rice fields, ducks could be an effective tool for integrated pest management and weed control.(Ju hui et al (2008). Ducks enhance the paddy field's ecological conditions for rice development, boosting biodiversity, the activity of soil organisms, and rice growth's energy efficiency.(Mohammadi etal 2012). The work of rice-duck integration is quite simple but the compliment duck provides is tremendous and the process is termed as duck effect. Duck effect includes weed control effect, pest control effect, full time ploughing and muddying effect, bird tillage effect, rice stimulation effect, methane suppressive effect etc. on Tamil Nadu, or South India, duck herds are permitted on the harvested rice fields, allowing them to select the fallen rice grains. This is in keeping with the ancient practice of keeping ducks in rice fields before planting or after harvest. However, it is investigated in Japan how rice and duck interact with one another. As a result, tiny rural farms engage in free-ranging, scavenging-duck husbandry as a supplemental farming method. Although performance under these circumstances favors improving soil health, waterfowl's more active foraging ability supports weed control. Since South East Asians relish ducks, it may be possible to produce rice and ducks together in South India, a new area for rice-duck farming. This experiment involving the integration of ducks and rice was conducted in order to study the effect of duck integration in rice fields and its impact on weeds, growth, and yield parameters with an eye toward economics. This was done in light of the significance of producing healthy output in ecological farming systems.

Materials and Methods

Field experiment was conducted at the Experimental farm, Department of Agronomy, Bharath Institute of Higher Education and Research, School of Agriculture, Selaiyur, Chennai. The weather of Selaiyur is moderately warm with hot summer months. While the maximum temperature ranges from 27.8 °C | 82.1 °F. At an average temperature of 31.4 °C | 88.5 °F, May is the hottest month of the year likewise at 24.1 °C | 75.4 °F on average, January is the coldest month of the year. The main treatment comprises of control (conventional method of rice cultivation), duck herding in puddled fields, duck herding in cropped fields, ducks herding in puddled and cropped field. The sub treatments include, un weeded control, twice hand weeding @ 20 and 40 DAT, inter cultivation with cono weeding and cono weeder plus hand weeding. The fields were laid out into four main plots of dimension 16m x 15m, with each subplot dimension of 5m x 4m. In the main plots, the treatments were taken up with off-season management practices. In the one unit of the four partitions, the ducks were allowed for herding in rice field for 10-15 days in puddled field to trace the impact on weed population and rice crop performance trace the impact on weed population and rice crop performance during cropped period. In the second partition of the experimental unit the ducks were allowed for herding in the cropped fields into which the duck entry was ensured at 5-7 DAT and extended up to panicle initiation. In the third unit earmarked in the experimental area, the duck herding was ensured during puddled and cropped fields. The ducks in the paddy fields was withdrawn at the time of panicle initiation. In the control plots deep ploughing with disc plough during the summer was taken, and allowed for exposure to sunlight for one month, before land preparation. The main field was puddled three times to bring the soil to a satisfactory colloidal condition and later, the field was levelled perfectly. The bunds of the plots were strengthened as and when required in order to prevent seepage of water into neighbouring plots. In treatment plots involving duck integration the nutrients added through duck manure was worked out and deducted while scheduling fertilizer application. The observations taken were weed count, weed DMP, weed control index, crop DMP, grain yield, straw yield and economics. The plot bunds were reinforced as and when necessary to stop water from seeping into adjacent plots. The nutrients provided by duck manure were calculated and subtracted when fertilizer application was scheduled in treatment plots containing duck integration. Weed count, weed DMP, weed control index, crop DMP, grain yield, straw yield, were observed and analysed statistically.

Weed control Index:

. Weed samples were collected from each plot by randomly placing rectangular iron frames (1 m2) at five locations in the tillering stage , 60 days after transplanting (DAT) and at the dynamic rice growth or initiation stage and weed count was registered ,later after removing the roots, the weeds were washed and dried in an oven (60 °C for 48 h) and the dry weight of the weeds was recorded.

Weed control efficiency (WCE%) was determined using the formula:

Weed control efficiency (WCE%) = (DMC - DMT) /DMC X 100

where,

DMC = weed dry matter in control field (rice only) and

DMT = weed dry matter in experimental fields.

Weed control index (WCI%) was determined using the formula:

Weed control index (WCI%) = (CMC - CMT) /CMC X 100

where,

CMC = weed count in control field (rice only) and

CMT = weed count in experimental fields.

Results and Discussion

The impact of duck foraging in puddled and cropped fields was best during the first season, registering the least amount of weeds (6.08 per m^2), followed by duck foraging in puddled fields (60.17 per m^2). The overall weed count was subsequently decreased in plots where ducks foraged in puddled and cropped fields during the second season to 5.58 per m^2. Duck foraging in puddled and transplanted fields outperformed all other key treatments in lowering the population of *Marselia quadrifoliata* and *Cyperus rotundus*, which was significantly responsible for the overall weed count. This is because the ducks foraging within the rows enabled the exposure of tubers and weeds seeds and in turn, were fed by them. Moreover the movement of these water fowls in the inter row spaces frequently disturbed the soil, thus deprived the germinated weed seeds to emerge and establish. This was earlier reported by [Alejar A.S. and Aragones M.,1989]. Similar to this, the interaction impact of ducks foraging in cropped and puddled conditions followed by cono weeder + one hand weeding demonstrated notable suppression of overall weed population, recording 5.77 m^2 and 5.67 per m^2 during I and II season. This is due to the fact that duck scavenging through weed control and bird tillage effect had already suppressed weed emergence up to flowering stage. In addition, the subsequent hand weeding followed by cono weeder gave remarkable results on weed control, which further checked the weed sprouts **[Table-1].** The same main treatment plus twice-weekly manual weeding proved to be the second-best because the treatments' synergistic effects favored crop performance [Mohammadi etal;2012].

The impact of *Marselia quadrifoliata* and *Cyperus rotundus* on the second excellent weed control in rice was particularly noticeable, and when used in conjunction with a cono weeder and one-handed weeding, duck scavenging in sodden and cropped fields was very noticeable. This might be because duck activity in the transplanted field disturbed the earth, suppressing the weed seedlings that had sprouted and burying the exposed weed seeds. This was earlier reported by [Chelladurai (2011), Wangchengyuh (2001)]. Similar impacts were observed in crop dry matter production, grain yield and straw yield as a result of duck herding in the rice fields. Ducks integration during the puddled and cropped stage in the first season performed the best recording 15.03 t per ha, 4.34 t per ha and 7.29 t per ha of crop DMP, grain yield, and straw yield respectively. The second season results were comparatively the same with duck integration during puddled and cropped field registering the highest DMP of 15.3 t per ha, grain yield of 4.88 t per ha, and straw yield of 7.58 t per ha **[Table-2].** Apart from helping to manage weeds, ducks' simple performance in the flooded and transplanted rice field is almost like a closed nutrition cycle. The integrated farming system has the ability to significantly contribute by encouraging interaction among component businesses and the efficient use of available resources. The technique of weed control in the farmed fields was created when the ducks were herded and fed on young weed plants and weed seeds. Additionally, the stomping action caused by their webbed feet oxygenated the water, promoted the robust growth of rice plant roots, and reduced the build-up of toxic gases in the rhizosphere (Quan GM etal,2008; FAO ,2020). The disturbed water and muddy field created by ducks' all-day walking, swimming, and ploughing activities may also inhibit the germination and growth of weeds by reducing light penetration in the water. This is in addition to the trampling and grazing effect of ducks on weeds and weed seeds. (Shekawat B.S etal; 2010). Therefore, the effects of bird tillage and rice stimulation, which were supported by the incorporation of ducks, favorably influenced crop performance and, consequently, yield metrics. All of these illustrated that rice-duck farming improved the paddy field water environment and nutrient supply, optimized the ecological environment of paddy field, and promoted the growth and development of rice. Duck integration appears to be the most effective system for weed control in transplanted rice. In addition, consistent expansion of duck droppings, as well as loosening of topsoil, can be useful to stimulate rice plant development due to better availability of additional nutrients, which indirectly helped to suppress weed development in the rice field. During the two year study, weed thickness and weed biomass decreased significantly. This review is consistent with previous findings of a reduction in grass thickness associated with scaffolding associated with fish and ducks (De Sousa etal., 2011; Long et al., 2013; Teng et al., 2016). Duck practices negatively affected the development of weeds (Zhang et al., 2009) and the establishment of weed seeds in rice fields (Li et al., 2012). The combined mixture ducks best controls the native grass area, after which it can be used as a mandatory weed control in transplanted rice or on the other hand in natural cultivation where the use of herbicides is reduced and eliminated. Ducks feed on broadleaf weeds first and then sedges and green weeds (Long etal., 2013). Our findings showed that although ducks do not like green weeds in the presence of broadleaf weeds, abundant weeds were mostly damaged, and trampled during duck herding, contributing to weed suppression for better rice development. **(Fig-1)**The water quality in the coordinated rice-fish-duck structure was marginally acidic in nature, possibly due to the continuous accumulation of duck excreta. Ducks reduce emissions of ozone-depleting substances (GHG) from a rice biological system (Xu et al., 2017; Zhao et al., 2019; Nayak et al., 2020). The release of methane from rice fields was radically reduced due to the increase of decomposable oxygen in the water and the release of the upper layer of the rice fields, which ultimately caused the most likely soil aeration of the rice fields.The interaction accelerates the methane-oxygen cycles that occur when the movement of methane slows down, as well as inhibiting the movement of methanogenic microorganisms, which further reduces the outflow of CH4.

Conclusion

Despite being practiced for many years, organic rice farming saw a decline in quality and productivity because of weeds, illnesses, and pests. From the current investigation, it can be concluded that pre-season management practices, such as duck scavenging in puddled and cropped fields combined with cono weeding plus one hand weeding played a very significant role in managing the weeds in wetland condition. This complex ecosystem has a long,indeed, increasing soil fertility status coupled with environmental sustainability and ecological stablility .And perhaps in the rice-duck ecology, stability ,sustainability and viability of the business are guaranteed contributions. The current study's findings showed that rice duck farming is highly profitable in addition to reducing weed and pest infestation, demonstrating the system's fitness. Since organic rice production eliminates the use of fertilizers, herbicides, and pesticides, it can be concluded that pre-season management practices, such as duck scavenging in puddled and cropped fields, are beneficial in complimenting the environment too. Although organic rice farming has been practiced for many years, its quality and productivity have declined due to weeds, diseases and pests. Based on the research to date, it can be concluded that pre-season management practices such as duckweed removal in ponds and marginal fields combined with weeding and one-handed weeding have played a very important role in weed control in wetlands. The results of the present study showed that rice cultivation is very profitable in addition to reducing weed and pest infestation, indicating the viability of the system. Since organic rice cultivation eliminates the use of fertilizers, herbicides and pesticides, it can be concluded that seasonal management practices such as weeding of rice fields and crops are also beneficial to the environment. The coordinated rice-duck framework could be another way to transform the conventional framework into natural agriculture, reducing natural corruption, and could be a way forward for ecologically sound viable rural practices.

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Table:1 Effect of duck integration and weed control on observations

Main treatment	Weed count /sqm		Weeddrymatter productionkg/ ha		Weedcontrol index (%)	
	I	II	I	II	I	II
Control	9.27 (96.67)	9.04 (82.90)	1113.14	1031.49	---	---
Duck herding in puddled field	6.17 (39.68)	6.92 (50.17)	472.52	471.52	44.88 (69.65)	40.00 (4.00)
Duck herding in cropped field	7.53 (58.79)	7.65 (59.74)	532.76	546.57	40.92 (43.11)	35.99 (35.06)
Duck herding in puddled and cropped field	6.08 (32.71)	5.58 (32.71)	399.15	404.05	49.88	46.76 (49.02)
SEd	0.26	0.20	22.33	21.16	0.70	10.52
CD(p=0.05)	0.52	0.40	44.65	42.34	1.38	20.33
Sub treatments						
Unweeded control	10.08 (102.81)	9.38 (88.79)	834.76	796.86	---	----
Twice hand weeding	7.67 (59.80)	7.29 (85.32)	657.22	641.51	37.36 (37.03)	36.46 (35.64)
Inter culturing with cono weeder	8.79 (78.07)	8.14 (66.97)	729.37	673.34	32.57 (29.31)^	32.50 (29.05)
Cono weeding + one hand weeding	5.77 (42.02)	5.67 (33.78)	503.60	449.81	46.5 r (52.21)	45.00 (50.11)
SEd	0.30	0.32	19.12	15.62	0.64	0.7
CD	0.61	0.64	38.24	31.26	1.27	1.50

1

Fig :1 DUCK EFFECT IN RICE PRODUCTION

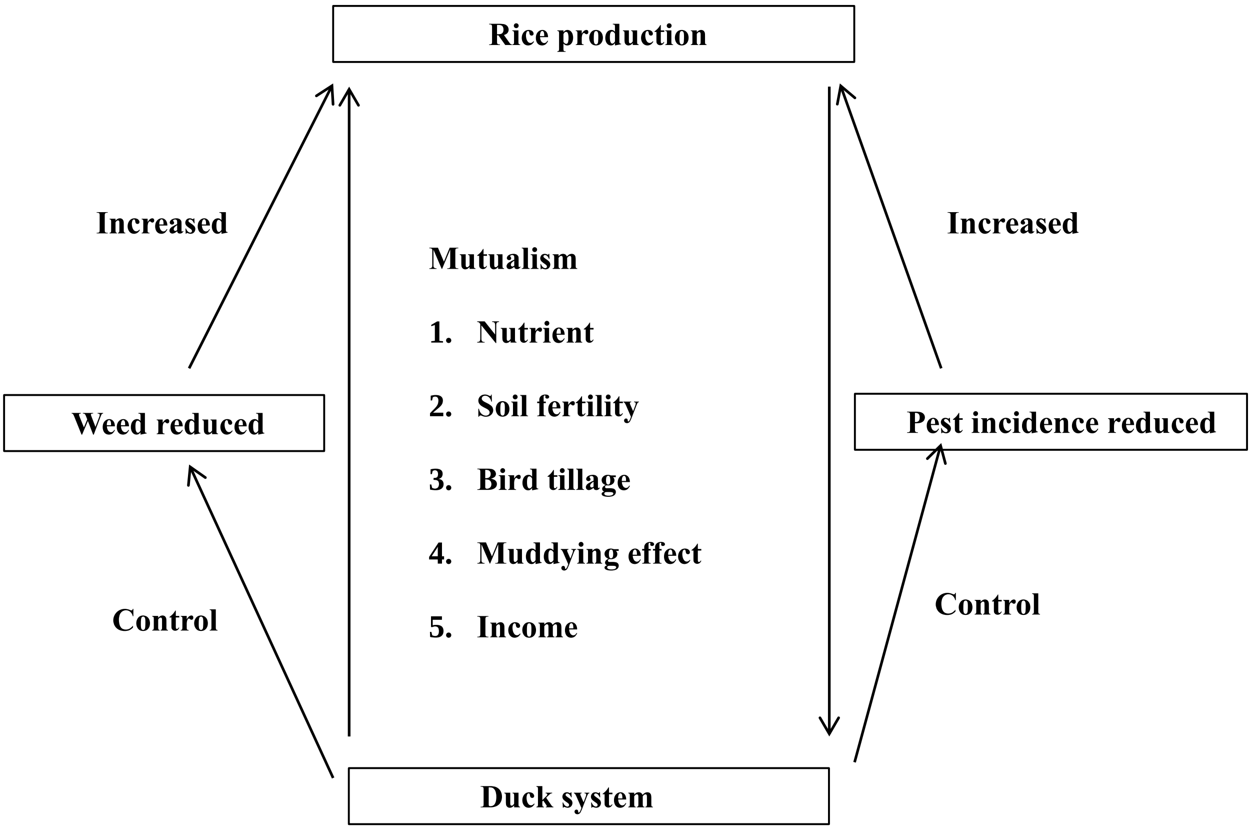

Table 2 Effect of duck integration and weed control grain and straw yieldtha-

Main Treatments

	Grain yield tha-1		Straw Yield tha-1	
Unweeded Control	**2.37**	**3.03**	**4.90**	**5.31**
Duck herding in puddled field	**3.97**	**4.23**	**7.29**	**5.999**
Duck herding in cropped field	**3.43**	**4.63**	**6.37**	**7.60**
Duck herding in puddled and cropped field	**4.03**	**4.90**	**6.37**	**7.60**
SED	**0.11**	**0.15**	**0.16**	**0.19**
CD P = 0.05	**0.22**	**0.29**	**0.35**	**0.39**
Unweeded Control	**2.31**	**2.96**	**5.03**	**5.30**
Twice Hand Weeding	**3.23**	**3.93**	**6.11**	**6.29**
Inter culturing with cono weeder	**3.01**	**3.52**	**5.74**	**5.98**
Conoweeding + Handweeding	**3.87**	**4.70**	**6.80**	**7.45**
SED	**0.07**	**0.12**	**0.10**	**0.17**
CD p = 0.05	**0.13**	**0.24**	**0.20**	**0.33**